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EPA

Setting Priorities for Hazardous Waste Minimization

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The purpose of this draft methodology document is two-fold: (1) to describe the work that the U.S. Environmental Protection Agency (EPA) has conducted to date in developing a methodology to set priorities in determining which combusted hazardous wastes EPA, States, industry, and other stakeholder groups should focus on regarding waste minimization, and (2) to present draft prioritization results.

Section E.S.1 provides the context for EPA's work on setting priorities for minimization of hazardous wastes and describes the review process for the draft methodology document. Section E.S.2 summarizes the Agency's methodology for identifying combusted hazardous wastes containing metals and/or halogenated organics and then presents the hazard-based methodology used to rank hazardous wastestreams and industrial processes. Section E.S.3 presents draft results. Finally, Section E.S.4 presents limitations of the analysis.

E.S.1 Introduction

E.S.1.1 Waste Minimization and Combustion Strategy

Although the Agency has devoted significant effort to evaluation and promotion of waste minimization in the past,[1] the Hazardous Waste Minimization and Combustion Draft Strategy[2] recently provided a significant impetus to this effort. The Draft Strategy had several components, among which was reducing the amount of hazardous waste generated in the United States. Other components of the Draft Strategy included strengthening controls on emissions from combustion units; enhancing public participation in facility permitting; conducting risk assessments as part of permitting; and enforcing regulatory and permit requirements.

Among the Draft Strategy's primary goals were establishing a strong preference for source reduction over waste management, and better addressing public participation in setting a national source reduction agenda.[3] In promoting waste minimization, the Agency will focus primarily on promoting source reduction for hazardous wastes and will promote environmentally sound recycling only where source reduction is not feasible.

To facilitate public dialogue on both waste minimization and combustion, EPA held a National Roundtable during November 1993 and a series of Regional Roundtables during the spring of 1994. At these Roundtables, public interest groups, citizens, industry, State and Federal regulators, and technical experts in pollution prevention were invited to discuss a broad range of

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[1] For example, EPA prepared a report to Congress, Minimization of Hazardous Wastes (October 1986), that summarized existing waste minimization activities and evaluated options for promoting waste minimization.

[2] U.S. EPA, May 1993.

[3] The Hazardous and Solid Waste Amendments (1984) to the Resource, Conservation, and Recovery Act (RCRA) together with the Pollution Prevention Act of 1990 identified a hierarchy of waste management options where reduction at the source was the preferred option, followed in turn by environmentally sound recycling, treatment, and finally disposal.

issues. The messages heard at the Roundtables are the building blocks for EPA's efforts to promote source reduction and recycling. These messages included: setting priorities based on risk; adopting a multi-media approach, considering risks via all media; focusing on persistent, toxic, bioaccumulative constituents in wastestreams; and encouraging movement up the waste management hierarchy.

E.S.1.2 Draft RCRA Waste Minimization National Plan

The Draft RCRA Waste Minimization National Plan (RWMNP)[4] is divided into two phases. Phase I of the RWMNP is the primary vehicle for promoting source reduction and recycling under the Waste Minimization and Combustion Strategy. Phase II of the RWMNP will then move beyond wastes managed in combustion units to promote source reduction and recycling for wastes managed by other practices, applying the messages heard and lessons learned during Phase I. As shown in Exhibit 1-1, the process of setting priorities is one of the building blocks for the RWMNP.

E.S.1.3 Review Process

The messages heard from stakeholder groups at the National and Regional Roundtables formed the foundation for development of the RWMNP and the prioritization methodology. Informal guidance on prioritization methodology development was provided by staff from a variety of Agency program offices during review of potential methodologies and development of wastestream data. The Agency also discussed comments on the RWMNP and prioritization methodology with representatives of some stakeholder groups (e.g., States and industry trade associations). Finally, EPA briefed the Science Advisory Board on the methodology and received some comments during a brief, informal consultation in June 1994.

The Agency plans to solicit and respond to comments on the prioritization methodology and results in several ways prior to finalizing Phase I of the RWMNP. The Agency will review and summarize the public comments provided both on the RWMNP and on this methodology document. The Agency will also be establishing a formal Agency workgroup to develop the final Phase I RWMNP, and one of the subcommittees on the workgroup will focus on reviewing and revising the prioritization methodology based on both internal EPA and stakeholder group comments. In addition, a focus group meeting is planned for September 1994 to formally obtain comment from stakeholder groups on the Draft RWMNP; part of this meeting will serve as a forum to obtain comment on details of the prioritization methodology.

E.S.2 Methodology

E.S.2.1 Methodology for Identifying Combusted Hazardous Wastes Containing Metals and/or Halogenated Organics

To characterize the universe of combusted hazardous wastes, EPA employed 1991 data from the Biennial Reporting System (BRS), the most comprehensive national data available in

[4] U.S. EPA, May 23, 1994.

Exhibit 1-1.
Summary of the Key Components of the Draft RCRA Waste Minimization National Plan

ESTABLISH GOALS

Reduce quantity and toxicity of hazardous waste through source reduction and then recycling

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SET PRIORITIES FOR SOURCE REDUCTION AND RECYCLING

- Rank wastestreams based on multi-media hazard and exposure potential, then
- Rank industrial processes based on hazard of wastestreams they generate
- Select priorities among industrial sectors, processes, wastestreams, and/or constituents

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IDENTIFY/EVALUATE SOURCE REDUCTION AND RECYCLING OPPORTUNITIES

With the ultimate goal of **optimizing source reduction** above other methods, when feasible.

Consider:

- Technical and economic feasibility
- Economic impacts
- Cross-media transfers

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ARRAY MECHANISMS FOR EFFECTING SOURCE REDUCTION AND RECYCLING

Non-regulatory vs. regulatory mechanisms.

Consider:

- Other EPA initiatives that are relevant
- Which option(s) will result in the greatest environmental benefits
- Resource constraints for effective outreach/implementation
- Our sphere of influence

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IMPLEMENT MECHANISMS

Employ regulatory development, guidance, permitting, voluntary challenge programs, and coordinate with Regions, States, technical assistance centers to both implement and develop measures of success.

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MEASURE PROGRESS BEING MADE

early 1994 on the generation and management of hazardous wastes in the United States.[5] EPA first estimated the quantities of hazardous wastes managed by combustion facilities (i.e., incinerators and burners and industrial furnaces (BIFs)). To focus on those combusted wastes affording the best initial opportunities for source reduction and recycling, EPA excluded combusted wastes that are not routinely generated (i.e., wastes from remediation, spill cleanup, and equipment decommissioning). "Secondary" hazardous wastes (i.e., residuals from treatment, disposal, and/or recycling of hazardous wastes) were also excluded, to avoid double counting between the hazardous wastes that were treated/disposed/recycled and their residuals.

Once the universe of combusted wastes had been identified, the BRS was used to determine the origins of these wastes (i.e., the industrial sectors and processes generating the wastes). The Agency is particularly interested in determining the origins of combusted wastes, since this information forms the foundation of later efforts in the RWMNP to identify, evaluate, and promote source reduction and recycling alternatives. Tracing the origins of wastes received at off-site combustion facilities proved to be particularly difficult, because it involved linking data from BRS reporting forms filed by the generators of wastes with corresponding data from forms filed separately by the combustion facilities receiving those wastes. Several specific factors made it difficult to link generation to off-site combustion:

- In many cases, the BRS records are missing facility identification numbers or other key data needed to make the link between generating and receiving facilities.

- Generating facilities tend to report quantities on an annual basis, whereas the receiving facilities often report quantities on the basis of the amount in individual shipments, and thus quantities often do not match well.

- Some of these wastes have a complex path from "cradle" to "grave." Much of the waste that is ultimately burned off site is first collected and commingled at intermediary facilities (such as fuel blenders) prior to combustion.

EPA was able to identify the origin of about 40 percent of the wastes managed off-site.

The Agency also used the BRS data as a starting point in assessing waste characteristics, since the BRS included information on the form of the waste (e.g., inorganic liquid or organic sludge) and, in some cases, on the constituents (i.e., chemicals) present in the waste that were reported under the Toxics Release Inventory. However, two of the most important data elements in assessing the potential hazard associated with wastestreams also are among the most difficult to characterize: the constituents present in the waste and their concentrations.[6]

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[5] The Agency recognizes that there have been some significant changes in waste generation and management since 1991. Nevertheless, the 1991 BRS data provide a useful and comprehensive basis for characterizing combusted hazardous wastes.

[6] These data elements are also important in measuring progress being made in minimizing hazardous wastes. Waste quantity provides only a partial picture of progress, since the concentrations and toxicities of constituents could increase at the same time that waste quantity decreased. (It should be noted that other factors are also important in measuring progress, such as economic conditions.)

EPA devoted significant effort to identifying constituents in combusted hazardous wastestreams and estimating approximate constituent concentrations. The Agency focused in particular on wastestreams containing metals and/or halogenated organics. Although the characterization effort was limited to wastestreams containing metals and/or halogens, the Agency identified other constituents (i.e., constituents that were not metals or halogens) also present in these wastestreams. To facilitate waste characterization, EPA grouped combusted wastestreams that were identical in terms of four key attributes: RCRA hazardous waste codes, industrial sector of the generator (i.e., based on the four-digit Standard Industrial Classification code), waste source, and waste form. The top 100 of these "wastestream combinations," in terms of quantity, were characterized; these top 100 wastestream combinations account for approximately 50 percent of all combusted wastestreams. In order to assess how representative these top 100 combinations are of the entire universe of combusted wastes, EPA compared the top 100 combinations with all remaining combusted wastestreams in terms of predominant waste forms, management locations, quantities, and other characteristics.

In characterizing the top 100 wastestream combinations, EPA assembled the best data that were readily available (e.g., data from technical background documents for hazardous waste listings and best demonstrated available technology (BDAT) determinations, and the 1986 Generator Survey). Not all information sources were available for each wastestream combination, so EPA had to apply judgement on when to use the sources and when to make assumptions to bridge data gaps.

E.S.2.2 Methodology for Prioritizing Wastestreams and Industrial Processes

A number of different EPA and State ranking methodologies were reviewed and evaluated against a set of key EPA considerations, in order to assess their applicability to scoring hazardous wastes. These considerations included:

- applicability to the goal of the RWMNP to reduce the quantity and toxicity of hazardous waste (indicating an approach focusing on the hazard of the wastes *as generated* (i.e., prior to management));
- consistency with the focus of Phase I of the RWMNP on combusted hazardous wastestreams (indicating an approach focusing on the hazard of wastes *as managed*);
- consistency with messages heard during the November 1993 Roundtable;
- ability to be quickly implemented with readily-available data;
- level of peer review; and
- appropriateness for national screening purposes and adaptability for Regional or State use based on their priorities.

The Agency attempted to balance these sometimes competing considerations in developing a national screening methodology that would serve as a first step in setting priorities for waste minimization. In reviewing potentially-applicable prioritization methodologies, the Agency focused first on approaches that would rank wastes based on their hazard as generated, in keeping with the broad goal o' the RWMNP to reduce the quantity and toxicity of hazardous wastes. In examining the hazarc wastes as generated, the Agency's objective was to identify and promote source reduction for ..stes that are the most pervasive, toxic, mobile, persistent, and/or bioaccumulative, considering the major environmental pathways of contaminant transport and exposure (air, surface water, ground water, soils, and the foodchain). This approach would potentially reduce not only the generation of hazardous wastes, but the release of toxic constituents to all media and the subsequent exposures of workers, the general public, and the environment.

A secondary consideration in developing EPA's system for prioritizing wastes was to identify wastes that would potentially pose the greatest risks when burned in combustion units, in keeping with the focus of Phase I of the RWMNP on combusted hazardous wastes. EPA did not attempt to actually estimate releases, exposures, and risk/hazard from combustion units (i.e., risk/hazard from wastes as managed) for the purpose of ranking wastestreams due to: the significant data requirements and apparent lack of screening methodologies to do this; the ambitious schedule for Phase I of the RWMNP; and the fact that Regions and/or States would potentially be better able and more suited to conduct these analyses. Instead, the Agency decided to focus on the characteristics of combusted wastestreams, focusing in particular on wastestreams containing metals and/or halogenated organic compounds.

A number of participants at the National Roundtable expressed particular concern about combustion of wastes containing metals and halogenated organic compounds. Metals are a concern since they are not destroyed during combustion and typically end up in ash, releases to air, and/or products (e.g., cement). All metals are persistent, and some are toxic and/or bioaccumulative. Some metals (e.g., copper) are also believed to act as catalysts in the synthesis of dioxins during combustion. Halogenated organic compounds are a concern since they may contribute to formation of dioxins during combustion. Aside from the potential for reduced risks from combustion, there may be other multimedia benefits from reducing generation of halogenated organic-containing wastestreams, since some halogenated compounds have been associated with depletion of stratospheric ozone and others have been linked with special ground water remediation problems. Furthermore, some halogenated organics do not degrade readily in the environment and tend to exhibit high human and ecological toxicities. Halogenated organics are also prominent on lists of "persistent bioaccumulators" that have been derived for various prioritization purposes.

Based on these and other considerations, the Agency selected a methodology relying primarily on a set of modified waste characteristics scoring algorithms from the Superfund Hazard Ranking System (HRS). Among the advantages of this methodology are the following: it includes a number of hazard-related prioritization criteria (i.e., waste quantity, constituent concentration, human and ecological toxicity, mobility, persistence, and bioaccumulation potential) and considers four primary pathways of potential contaminant transport and exposure (i.e., air, surface water, ground water, and soils); it could be quickly implemented with limited modification and with readily-available data; and it has been extensively peer-reviewed.

The basic steps involved in scoring and ranking a given wastestream include: (1) estimating the mass of each constituent in the wastestream by multiplying waste volume times constituent concentration; (2) selecting the highest pathway score[7] for each constituent, reflecting the pathway by which the constituent presents the greatest hazard; (3) calculating the constituent hazard score for each constituent by multiplying constituent mass times pathway score; and (4) selecting the highest among the constituent hazard scores to represent the wastestream score.

The methodology was used to score the top 100 wastestream combinations identified earlier. Wastestream scores were then used to rank industrial processes (i.e., sources) by apportioning each wastestream score among the industrial processes generating it on a quantity basis.

E.S.3 Draft Results

E.S.3.1 Draft Results: Combusted Hazardous Wastes Containing Metals and/or Halogenated Organics

Overview of Combusted Wastes

In 1991, approximately 310 million tons of hazardous waste was reported in the BRS to be managed in units subject to RCRA requirements. Of this amount, approximately 3.6 million tons (or 1.2 percent) was managed by combustion. To focus on combusted wastes affording the best initial opportunities for source reduction and recycling, EPA excluded non-routinely-generated wastes and secondary wastes, leaving about 3.0 million tons of combusted waste for further analysis. Approximately two thirds of this total was combusted at on-site facilities, while the remaining third was sent off site for combustion at commercial or non-commercial facilities.

Characteristics and Origins of Combusted Wastes

Of the 3.0 million tons of routinely-generated primary hazardous waste combusted in 1991, approximately 55 percent was managed in incinerators and 45 percent in BIFs. The bulk of this quantity was liquids: approximately half was classified as organic liquid and one-fourth as inorganic liquid. Sludges and solids accounted for one eighth of the quantity, and the remainder was of unknown form.

Three specific source categories contributed over 50 percent of the combusted waste quantity: product distillation (23 percent), spent process liquids removal (17 percent), and by-product processing (11 percent). For 28 percent of the quantity, the source could not be identified.

Although close to 400 industries (as defined by 4-digit SIC code) generated wastes destined for combustion in 1991, much of the quantity was concentrated in a few sectors. These sectors included: industrial organic chemicals (SIC 2869) with 40 percent of the quantity, pesticides and agricultural chemicals (SIC 2879) with 9 percent, and plastic materials and resins (SIC 2821) with 6 percent.

[7] The pathway score corresponds to the *toxicity/combined factor value* in the HRS.

Combustion facilities in EPA Region 6 generated and managed close to 50 percent of combusted wastes in 1991. Regions 7, 5, and 2 each had approximately 10 percent of the quantity. Among states, Texas generated and managed about 40 percent of the combusted waste, followed by Missouri, Louisiana, Indiana and New Jersey, each with less than 10 percent.

Characteristics and Origins of Top 100 Wastestream Combinations

As discussed above, EPA determined which constituents were present in large-volume "wastestream combinations" and identified the top 100 of these combinations containing metals and/or halogenated organics. These top 100 combinations, representing approximately 50 percent of routinely-generated primary combusted wastes, were used as the basis for setting priorities for hazardous waste minimization.

The Agency characterized the top 100 wastestream combinations in a number of ways. In addition, EPA compared them with the remaining 18,922 wastestream combinations, to assess how representative the top 100 combinations were of combusted hazardous wastes generally.

The predominant waste forms, both among the top 100 wastestream combinations and for the remaining set, were organic liquids (47 percent and 54 percent, respectively) and inorganic liquids (35 percent and 14 percent, respectively). Waste form was not reported (or had an invalid entry) for about 5 percent of the top 100 combinations, and almost 20 percent of the remaining wastes.

On-site management was more common for the top 100 wastestream combinations than for the remaining wastestreams. Approximately 75 percent of the top 100 were managed on site, whereas 57 percent of the remaining wastestreams were managed on site. This finding comports with the fact that the top 100 combinations represent much larger waste quantities, on average, than the remaining wastestreams. In general, the larger the wastestream, the more likely it is to be managed on site due to economies of scale in waste management.

For the top 100 wastestream combinations, two-thirds of the 1.1 million tons managed on site in 1991 was managed in incinerators (with the rest managed in BIFs), while for the 380 thousand tons managed off site, less than 10 percent was managed in incinerators. Commercial facilities managed about two-thirds of the 380 thousand tons that went off site; BIFs accounted for most of this commercial management.

Two industry groups generated 52 percent of the waste in the top 100 wastestream combinations: industrial organic chemicals (SIC 2869) with 37 percent and agricultural chemicals (SIC 2879) with 15 percent. No other industry accounted for more than 7 percent of the quantity. A similar pattern emerged for the remaining wastestreams, where industrial organic chemicals generated 38 percent, agricultural chemicals generated 4 percent, and no other industry generated a significant portion of the quantity.

The sources of wastes were nearly identical for the top 100 wastestream combinations and for the remaining wastestreams. In both cases, the source generating the largest quantity was product distillation, followed by spent process liquids removal and by-product processing.

EPA has considerable experience in developing waste minimization strategies for routinely-generated wastes where the source is a well-defined, integral part of the production process. However, there are several categories of wastes among the top 100 wastestream combinations that are not well-defined (e.g., due to missing data) or where sources are not part of production processes (e.g., pollution control devices). These wastes, which represent about 35 percent of the total quantity for the top 100 combinations, would require further study (and potentially a better understanding of "upstream" processes) in order to evaluate waste minimization opportunities. These waste types include: process blank, unknown, or "other" (24 percent of total quantity); still bottoms (6 percent); and wastes from waste treatment and "other" pollution control (5 percent).

E.S.3.2 Draft Results: Prioritization of Wastestreams and Industrial Processes

EPA presents the draft results from the scoring and ranking analysis first in terms of wastestream combinations, and then aggregated based on origins of the wastes. Note that the numeric hazard scores do not correspond to any absolute measure of the magnitude of hazard or risk; only the relative difference between the wastestream combination scores is significant.

The range of scores for each of the top 100 wastestream combinations is quite broad, from about 5.1E+06 to 7.1E+13,[8] and the total hazard score (summed across all wastestream combinations) is 1.9E+14. The draft results indicated that:

(1) Most of the hazard -- almost 85 percent of the total hazard score -- is accounted for by the top five wastestream combinations. Three of these five wastestream combinations belong to SIC 2869 (Industrial Organic Chemicals) and Source Code A33 (Product Distillation);

(2) Although there is a very large range in the scores (almost seven orders of magnitude), 73 of the 100 fall within a two order of magnitude range, between 1E+10 to 1E+12. Thus, as measured by the scoring system, there is a fairly large set of wastes with a similar degree of hazard, and smaller sets of relatively high-hazard and low-hazard wastes that are distinctly different;

(3) The hazard of a given wastestream combination is not driven by waste quantity alone, but reflects both the waste quantity and the hazard of the waste constituents. The components of the scoring system driven by constituent properties (e.g., toxicity, persistence, bioaccumulation potential) appear to be at least as important as waste quantity in determining the score.

The scores for the individual wastestream combinations can be summed across factors they have in common, i.e., waste form, source of the waste, and SIC of the generator. The results discussed below, which indicate trends in total hazard potential, compare the sum of hazard scores for a given factor to the total hazard score summed across all wastestream combinations.

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[8] For scientific notation, this report uses a convention used frequently in computer programming, i.e., the digits following a capital E represent the exponent to the power of 10. For example, 2E+02 represents 2 x 10^2, or 200.

Three waste forms -- "other" organic liquids, concentrated aqueous solutions of other organics, and resins -- comprise almost 92 percent of the total hazard score (primarily because they are associated with the top five wastestream combinations). Non-halogenated and halogenated solvents comprise most of the remaining share of the total hazard score.

EPA also summed the hazard scores across all of the SIC/source combinations. About 85 percent of the total hazard score is contributed by three combinations:

- SIC Code 2869 (Industrial Organic Chemicals)/Source Code A33 (Product Distillation);
- SIC Code 2833 (Medicinal Chemicals and Botanical Products)/Source Code A32 (Product Filtering); and
- Non-classifiable SIC Code/Unspecified Source Code.

These constitute the combinations representing the top five wastestream combinations. The next combination, unknown SIC and unknown source, primarily comprises non-halogenated solvents (the seventh ranked wastestream combination) and waste oils (the tenth ranked wastestream combination).

Most of the ten top-ranked wastestream combinations represent a small number of BRS records of wastestreams at a few facilities, as shown below.

Wastestream Combination Rank	1	2	3	4	5	6	7	8	9	10
No. of BRS Records of Wastestreams	3	1	1	2	1	2	12	1	1	450
No. of Facilities	1	1	1	1	1	1	12	1	1	450
Place of Management	on-site	on-site	on-site	on-site	off-site	on-site	off-site	on-site	on-site	both
Region	VI	I	III	VI	V	VI	I,II,III	IV	III	many
State	TX	CT	PA	TX	IN	TX	CT,MA, NJ,NY, PA,VA, WV	KY	VA	many

The nine top-ranking wastestream combinations are focused in 20 or fewer facilities; slightly less than half of these facilities manage their wastes on site. This indicates that for the nine highest-hazard wastestream combinations, there is an opportunity to focus the next phase of the prioritization and waste minimization effort within a relatively small set of facilities. This may allow for site-specific data collection and evaluation of waste minimization potential. The tenth-ranked wastestream combination, waste oils, is generated by a much larger set of facilities, many of whom ship wastes off-site.

The draft results indicate that a majority of the nine top-ranking wastestream combinations are focused primarily in the States of Texas, Connecticut, Pennsylvania, and Virginia. Three of these states account for a large percentage of the total hazard score across all wastestream combinations, i.e., Texas (≈ 53 percent), Connecticut (≈ 20 percent), and Pennsylvania (≈ 13 percent).

E.S.4 Limitations

The results described in this report are subject to a number of important limitations. The Agency emphasizes that the draft results must be viewed in the context of these limitations. The concluding sections of Chapters 2 and 3 describe them; a brief summary follows.

Limitations in Identifying and Characterizing Combusted Wastes

- The most recent comprehensive data available on waste generation and management are from 1991.
- Data used in this analysis do not reflect recent State updates.
- Data were missing for some key data fields in the BRS.
- Constituent content and concentration estimates are rough approximations.
- The Generator Survey and other sources used to characterize wastes may not be current.
- Generator Survey data are likely to be more accurate for metals than for organics.

Limitations in Prioritizing Wastestreams and the Industrial Processes Generating Them

- Hazard scores are subject to the uncertainty in the underlying waste characterization/constituent concentration data.
- The method incorporates assumptions and limitations of the HRS.
- The approach does not account for hazards related to corrosive and ignitable/flammable nature of some hazardous wastestreams.
- The method does not directly address releases and exposures, particularly post-combustion releases and exposures.
- The method does not correspond directly to a measure of "absolute" risk.

As a practical matter, any method that seeks to simulate complex environmental processes, but is founded on simple scoring algorithms and uncertain data, will always carry with it important limitations. Some of these limitations may become less constraining as the approach is refined and improved. The Agency looks forward to receiving comments on the proposed approach for setting priorities for waste minimization, and will carefully consider all information it receives.

CHAPTER 1
INTRODUCTION

The purpose of this draft methodology document is two-fold: (1) to describe the work that the U.S. Environmental Protection Agency (EPA) has conducted to date in developing a methodology to set priorities in determining which combusted hazardous wastes EPA, States, industry, and other stakeholder groups should focus on regarding waste minimization, and (2) to present draft prioritization results.

This chapter provides the context for EPA's work on setting priorities for minimization of hazardous wastestreams. Section 1.1 provides an overview of the Hazardous Waste Minimization and Combustion Draft Strategy and the related Draft RCRA Waste Minimization National Plan, which provided the impetus for development of the prioritization system. Section 1.2 discusses the review process for the draft prioritization methodology and results. Finally, Section 1.3 provides an overview of the remaining chapters and appendices.

1.1 OVERVIEW OF HAZARDOUS WASTE MINIMIZATION AND COMBUSTION DRAFT STRATEGY AND DRAFT RCRA WASTE MINIMIZATION NATIONAL PLAN

1.1.1 Waste Minimization and Combustion Strategy

Although the Agency has devoted significant effort to evaluation and promotion of waste minimization in the past,[1] the Hazardous Waste Minimization and Combustion Draft Strategy[2] (referred to throughout this document as the "Draft Strategy") recently provided a significant impetus to this effort. The Draft Strategy was designed, among other things, to reduce the amount of hazardous waste generated in the United States. Other components of the Draft Strategy included: strengthening federal controls governing hazardous waste incinerators and boilers and industrial furnaces (BIFs); enhancing public participation at the time of and prior to permitting a facility; conducting full risk assessments at each combustion facility to be permitted and taking that assessment into consideration at the time of permitting; and ensuring that regulatory and permit requirements are vigorously enforced.

Among the Draft Strategy's primary goals were establishing a strong preference for source reduction over waste management and better addressing public participation in setting a national source reduction agenda.[3] In promoting waste minimization, the Agency will focus primarily on promoting source reduction for hazardous wastes and promote environmentally sound recycling only where source reduction is not feasible.

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[1] For example, EPA prepared a report to Congress, Minimization of Hazardous Wastes (October 1986), that summarized existing waste minimization activities and evaluated options for promoting waste minimization.

[2] U.S. EPA, May 1993.

[3] The Hazardous and Solid Waste Amendments (1984) to the Resource, Conservation, and Recovery Act (RCRA) together with the Pollution Prevention Act of 1990 identified a hierarchy of waste management options where reduction at the source was the preferred option, followed in turn by environmentally sound recycling, treatment, and finally disposal.

To facilitate public dialogue on both waste minimization and combustion, EPA held a National Roundtable during November 1993 and a series of Regional Roundtables during the spring of 1994. At these Roundtables, public interest groups, citizens, industry, State and Federal regulators, and technical experts in pollution prevention were invited to discuss a broad range of issues. Some key messages related to waste minimization that came out of these Roundtable discussions included:

- Emphasize the multi-media aspects of pollution prevention. Focus on pollution prevention in all aspects of waste management, and assure that we really get source reduction, rather than a shifting of pollutants from one environmental media to another.

- Reinforce the waste management hierarchy that has been stated in RCRA, the Pollution Prevention Act, and reiterated in Administrator Browner's memo on EPA's Pollution Prevention Policy. Demonstrate a strong preference for source reduction by bold action, including resource shifts from end-of-pipe activities to source reduction initiatives.

- Allow flexibility to both States and industry to undertake efforts that will achieve real reductions in pollution and generation of wastes.

- Prioritize all efforts in pollution prevention based on the highest risks.

- Establish expectations, accountability, and recognition of continuous improvement in both the private and public sectors. Develop objective, measurable indicators of success.

- Empower the public. Involve the public more effectively in shaping EPA's pollution prevention policies.

These messages are the building blocks for EPA's efforts to promote source reduction and environmentally-sound recycling.

1.1.2 Draft RCRA Waste Minimization National Plan

The Draft RCRA Waste Minimization National Plan (RWMNP)[4] is divided into two phases. Phase I of the RWMNP is the primary vehicle for promoting source reduction and recycling under EPA's Hazardous Waste Minimization and Combustion Draft Strategy; as part of this phase, EPA identified hazardous wastes containing metals and halogenated organics as a priority. Phase II of the RWMNP will then move beyond wastes managed in combustion units to promote source reduction and recycling for wastes managed by other practices, applying the messages heard and lessons learned during Phase I.

As shown in Exhibit 1-1, the process of setting priorities is one of the key building blocks for the RWMNP. This process involves ranking hazardous wastestreams based on their hazard and then ranking industrial processes (or sources) based on the wastestreams they generate.

[4] U.S. EPA, May 23, 1994.

EXHIBIT 1-1.
SUMMARY OF THE KEY COMPONENTS OF THE DRAFT RCRA WASTE MINIMIZATION NATIONAL PLAN

ESTABLISH GOALS

Reduce quantity and toxicity of hazardous waste through source reduction and then recycling

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SET PRIORITIES FOR SOURCE REDUCTION AND RECYCLING

- Rank wastestreams based on multi-media hazard and exposure potential, then
- Rank industrial processes based on hazard of wastestreams they generate
- Select priorities among industrial sectors, processes, wastestreams, and/or constituents

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IDENTIFY/EVALUATE SOURCE REDUCTION AND RECYCLING OPPORTUNITIES

With the ultimate goal of **optimizing source reduction** above other methods, when feasible.

Consider:
- Technical and economic feasibility
- Economic impacts
- Cross-media transfers

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ARRAY MECHANISMS FOR EFFECTING SOURCE REDUCTION AND RECYCLING

Non-regulatory vs. regulatory mechanisms.

Consider:
- Other EPA initiatives that are relevant
- Which option(s) will result in the greatest environmental benefits
- Resource constraints for effective outreach/implementation
- Our sphere of influence

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IMPLEMENT MECHANISMS

Employ regulatory development, guidance, permitting, voluntary challenge programs, and coordinate with Regions, States, technical assistance centers to both implement and develop measures of success.

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MEASURE PROGRESS BEING MADE

The next step is to identify source reduction and recycling opportunities for priority wastestreams and industrial processes and then evaluate their technical and economic feasibility, economic impacts, and potential adverse environmental effects. This effort will involve a number of parties, including EPA's Office of Research and Development and Office of Solid Waste, industry, technical assistance centers, and universities.

Where source reduction and environmentally-sound recycling appear to be feasible alternatives, the effectiveness of different voluntary and regulatory mechanisms for promoting them will be examined. EPA will then encourage all stakeholders to identify the roles they can play in further developing and implementing these mechanisms. The last step in the RWMNP is measuring the progress being made.

The Agency is currently soliciting public comment on the Draft RWMNP. In addition, EPA plans to conduct a focus group discussion during September 1994 to obtain public comment on the different components of the RWMNP, including the prioritization methodology.[5]

1.2 PROCESS FOR REVIEWING DRAFT PRIORITIZATION METHODOLOGY AND RESULTS

As discussed above, the messages heard from stakeholder groups at the November 1993 National Roundtable and the spring 1994 Regional Roundtables formed the foundation for development of the RWMNP and the prioritization methodology. Informal guidance on methodology development was provided by staff from a variety of Agency program offices during review of potential methodologies and development of wastestream data. The Agency also discussed comments on the RWMNP and prioritization methodology with representatives of some stakeholder groups (e.g., States and industry trade associations). Finally, EPA briefed the Science Advisory Board on the methodology and received some comments during a brief, informal consultation in June 1994.

The Agency plans to solicit and respond to comments on the prioritization methodology and results in several ways prior to finalizing Phase I of the RWMNP. The Agency will review and summarize the public comments provided both on the RWMNP and on this methodology document. The Agency will also be establishing a formal Agency workgroup to develop the final Phase I RWMNP, and one of the subcommittees on the workgroup will focus on reviewing and revising the prioritization methodology based on both internal EPA and stakeholder group comments. In addition, a focus group meeting is planned for September 1994 to formally obtain comment from stakeholder groups on the Draft RWMNP; part of this meeting will serve as a forum to obtain comment on details of the prioritization methodology.

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[5] The draft RWMNP discussed an earlier version of the prioritization methodology and presented some initial prioritization results for the purpose of illustration. Attachment 1 to the RWMNP, which showed a preliminary summary of high-ranking industry/source combinations, illustrated the level of detail that could be provided in identifying industrial sources of hazardous waste generation. However, significant changes have been made to the underlying waste characterization data, and ranking results have changed. See Chapter 3 for the revised ranking results.

1.3 ORGANIZATION OF DOCUMENT

Chapter 2 discusses the methodology used to identify the universe of combusted hazardous wastes containing metals and/or halogenated organics and presents an overview of the results of this process. Chapter 3 then discusses the selection of a hazard-based prioritization methodology and the results of scoring wastestreams and industrial processes based on this methodology.

A series of appendices provide more detailed information on the prioritization methodology and results:

- Appendix 1 provides sample Biennial Reporting System (BRS) data forms.
- Appendix 2 describes the codes used in the BRS.
- Appendix 3 explains the process by which EPA linked information on waste generation to information on off-site waste management.
- Appendix 4 identifies sources of information the Agency used to characterize waste composition.
- Appendix 5 explains EPA's assumptions in matching wastes reported in the 1991 BRS to wastes described and characterized in the 1987 Generator Survey.
- Appendix 6 provides detailed waste characterization data for the highest-quantity combusted wastestreams.
- Appendix 7 comprises a set of summaries, developed by EPA, of prioritization systems.
- Appendix 8 lists hazard data and pathway scores from the Superfund Chemical Data Matrix, used in the Hazard Ranking System (HRS) and adapted for use in this report.
- Appendix 9 lists the states and regions in which the top 100 combusted wastestreams occur.

CHAPTER 2
IDENTIFYING COMBUSTED HAZARDOUS WASTES CONTAINING METALS AND HALOGENATED ORGANICS

This chapter summarizes EPA's methodology for identifying hazardous wastes containing metals and/or halogenated organics managed in incinerators and in boilers and industrial furnaces (BIFs). The first section of this chapter details the specific approach used to identify these wastes; at the end of this section, several specific issues are listed on which EPA invites comment. The second section presents a summary of results, and the last section presents limitations of the methodology and the data.

2.1 METHODOLOGY

The methodology for identifying waste minimization priorities requires wastestream-specific information on waste generation and management. The Biennial Reporting System (BRS) data for 1991 represent the most comprehensive data available as of early 1994 to characterize national waste generation and management[1]. Thus, the methodology relies heavily on the BRS data. Section 2.1.1 describes the structure of the BRS, and some of the techniques used to manipulate the data.

EPA analyzed the BRS data to determine the universe of combusted hazardous wastes, that is, wastes managed in incinerators and BIFs. The overall purpose of this analysis is to develop waste minimization priorities, which will serve as the basis for evaluating specific waste minimization opportunities at the industry and process level. Thus, the analysis involved identifying combusted wastes and evaluating the origins of these wastes, as described in Section 2.1.2.

Within the universe of combusted wastes, the Agency decided to focus on those wastes containing metals and/or halogenated organics. This decision was based on input from participants in a series of national and regional Waste Minimization Roundtables, as well as several factors related to human health and ecological risk. To characterize these combusted wastes, it was necessary to identify the constituents present and to estimate their concentrations. Section 2.1.3 describes this step, which is the final prerequisite to developing and applying a hazard-based scoring system for setting waste minimization priorities.

2.1.1 Biennial Reporting System (BRS) Data Structure

The primary data used in the analysis were obtained from EPA's BRS database, which contains information collected from the 1991 Hazardous Waste Reports. Every two years the Agency collects data on hazardous waste from generators and treatment, storage, and disposal facilities under the authority of Sections 3002 and 3004 of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of

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[1] The Agency is aware of the revisions made to the BRS data during June 1994, based on the Capacity Assurance Plans (CAPs) submitted by the States, and plans to revise the analysis based on the updated information.

1984. The data are entered into an electronic data management system by the States. The system is maintained by the Agency on the EPA IBM mainframe cluster.

BRS data are stored in several relational database files. A relational database file system is analogous to a simplified family tree. In this system there is one parent per child; parents can have multiple children, and their children can have multiple children, and so on. In the relational database system, there are parent records, child records, and grandchild records. For the purpose of this document, the terms database, file, and table are synonymous, and are used interchangeably for describing the BRS data.

The 1991 Hazardous Waste Report contains six forms:

(1) Form IC (Identification and Certification) - All sites that are required to submit the 1991 Hazardous Waste Report completed this form;

(2) Form GM (Waste Generation and Management) - All facilities subject to the reporting requirements that generated or shipped off site RCRA hazardous waste during 1991 completed this form;

(3) Form WR (Waste Received From Off Site) - All sites that received RCRA hazardous waste from off site during 1991 completed this form;

(4) Form PS (Waste Treatment, Disposal, or Recycling Process System) - All sites that had an on-site hazardous waste treatment, disposal, or recycling process system during 1991 completed this form, including sites with new units for which there were firm plans, or closing units in the closure process;

(5) Form WM (Waste Minimization) - All large quantity generators and facilities with treatment, disposal, or recycling units completed this form; and

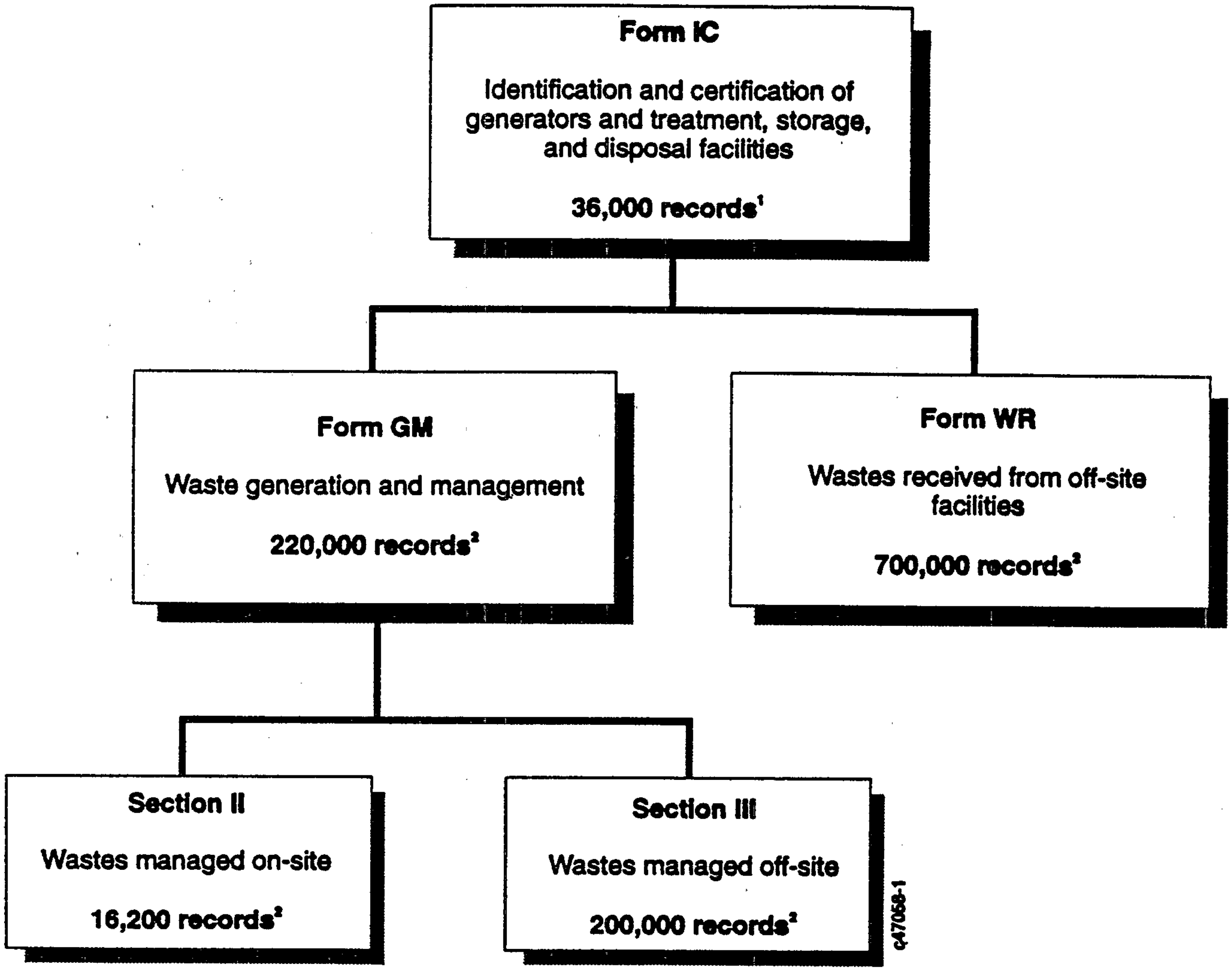
(6) Form OI (Off-site Identification) - An optional form to be completed by the sites, based on their State's requirements.

Exhibit 2-1 shows that the IC Form is the "eldest" form (i.e., parent to all other forms) in the BRS system. The IC Form contains one record for each facility uniquely identified by the EPA ID number. All other forms (i.e., GM, WR, PS, and WM Forms) are children of the IC Form. Since each IC Form (i.e., each facility) can have several of the children forms, each type of child defines a new table in the IC Form.

Exhibit 2-2 presents some of the key data elements used in the analysis and identifies which of the BRS Forms contained those data elements. Sample BRS Data Forms are presented in Appendix 1. Please note that the Agency has not yet analyzed data from Form WM. EPA expects to compile and analyze data from this form in examining waste minimization opportunities.

The BRS has been used to analyze waste minimization opportunities, treatment and disposal capacity, generation patterns, and recycling. As discussed later in the limitations section, EPA recognizes that there have been some significant changes in waste generation and

EXHIBIT 2-1. RELATIONSHIPS BETWEEN BRS FORMS



[1] *Number of records is for all sites required to submit Hazardous Waste Reports in 1991.*

[2] *Number of records is for all hazardous wastes generated and/or managed in 1991.*

EXHIBIT 2-2. KEY DATA ELEMENTS IN THE BRS

Data Element	GM Form	WR Form
Waste Identification and Management:		
Generating Facility ID	✓	✓
Management Facility ID	✓	✓
RCRA Waste Code(s)	✓	✓
Waste Form	✓	✓
Quantity Managed	✓	✓
Management System	✓	✓
Constituents in the Waste[a]	✓	
Waste Origins Information:		
Standard Industrial Classification (SIC)	✓	
Waste Origin[b]	✓	
Source/process	✓	

[a] Constituents reported to the Toxics Release Inventory (TRI).
[b] Waste Origin refers to a description of the process or activity that was the source of the waste.

management since 1991. Nevertheless, the 1991 BRS data are the most recent data available and provide a useful and comprehensive basis for characterizing and enumerating combusted wastes.

2.1.2 Identifying Combusted Wastes and Their Origins

As shown in Exhibit 2-2, one of the data elements in the BRS is the management system, i.e., the type of unit used to manage the waste. For this project, EPA defined combusted wastes as those wastes managed in incinerators or for energy recovery.[2] To focus on those combusted wastes which afford the best initial opportunities for source reduction and recycling, EPA excluded wastes that are not routinely generated (i.e., wastes that are generated on a one-time or intermittent basis):

[2] BRS system type codes M041 - M049 define incineration processes, and codes M051 - M059 correspond to management for energy recovery, i.e., combustion in boilers and industrial furnaces. Appendix 2 presents BRS code descriptions for all codes used in the BRS data forms. Note that wastestreams that could potentially be managed by combustion given their organic content (i.e., combustible wastestreams) but that were managed by other practices in 1991 were not addressed. EPA plans to address these wastestreams as part of Phase II of the RCRA Waste Minimization National Plan.

- Remediation wastes (source codes A61-A69); and

- Spill cleanup, equipment decommissioning, and other remedial activity wastes (origin code 2).

EPA also excluded residuals from on-site treatment, disposal, and recycling of hazardous waste (i.e., secondary hazardous wastes) (origin code 5), in order to avoid double-counting between the hazardous wastes that were treated/disposed/recycled and their residuals. Thus, EPA's prioritization scheme is focussed on those primary hazardous wastes that are routinely generated.

For identifying wastes combusted *on* site, data from the on-site management section (Section II) of the GM Form were used. For identifying wastes combusted *off* site, data reported in the WR Form rather than data reported in the off site management section (Section III) of the GM Form were used. The reason for using WR data rather than GM data is that WR data are believed to provide a more reliable picture of how the waste was *managed* (for purposes of this analysis, whether the waste was combusted or not). Even though generators may have better knowledge of their wastestreams, they sometimes speculate on its management off site when filling out the GM Form. For several reasons, the receiver would determine the exact properties (and quantity) and appropriate management of the waste prior to treating it:

- To determine the appropriate treatment system;

- To determine the cost of treating the wastestream; and

- To avoid liability resulting from not having treated the waste to land disposal restriction (LDR) standards.

Using the GM Form to identify wastes combusted on site, and the WR Form to identify wastes combusted off site, the Agency determined the respective quantities to be 2.00 million tons and 1.04 million tons, for a total of about 3.04 million tons/year of routinely generated combusted wastes.

Although the WR Form reliably identifies the management method for wastes sent off site, it does not provide information on waste origins, as indicated by Exhibit 2-2. Because information on the origins of the wastes is essential for identifying waste minimization opportunities, the Agency developed a technique to merge data from the WR and GM forms (i.e., to identify waste source information from the GM Form for the wastes reported as combusted in the WR Form).

This technique relied primarily on matching the GM and WR records based on their common elements -- generator and management facility identification numbers, RCRA waste codes, management system type, and waste form codes. The process yielded relatively few exact matches; only about 8 percent of the WR Form data (on a waste quantity basis) corresponded perfectly to GM Form data. Initially, this left a large gap in the origins information for those wastes managed off site. The Agency carefully investigated each of the top 50 records by waste volume (as reported in the WR Forms) that remained unmatched; at this point, those records comprised 50 percent of the total unmatched quantity. EPA was able to locate GM records that corresponded to some of these WR records. This exercise provided insights that were used to set up decision rules for a final computerized matching process, using relaxed matching criteria (e.g., allowing matches where waste quantities were within 25 percent of each other -- see Appendix 3 for a detailed description of the matching process). After completion of the process, about 60 percent of the quantity of waste combusted off site (or about 20 percent of the total combusted waste) could not be matched with corresponding GM data on waste origins.

Much of the remaining "unmatched" quantity is associated with BRS records where the facility identification numbers or other key data are missing. Another factor making it difficult to match the GM and WR records is that the generating facilities tend to report quantities on an annual basis, whereas the receiving facilities often report quantities on the basis of the amount in individual shipments. Finally, it is difficult to track origins for some of these wastes because they have a complex path from "cradle" to "grave." Much of the waste that is ultimately burned off site is first routed from a generating facility to a fuel blending facility, where it may be processed in a way that results in changes in the RCRA codes and regulatory status.[3] For the purpose of this initial examination of combusted wastes, EPA did not attempt to match WR records back through fuel blenders to generators, nor did it account for other situations where there are intermediate facilities that store or treat wastes prior to off-site combustion. Thus, while wastes routed through intermediaries to incinerators or BIFs are included in EPA's estimate of total combusted waste, the origins of these wastes are currently unknown.

2.1.3 Identifying Constituents and Concentrations

Having identified the universe of wastes managed in combustion units and their origins, the next step in the methodology was to determine which of those wastes contain metals and/or halogenated organics. As explained in more detail in Chapter 3 of this report, the Agency decided to emphasize wastes bearing metals and halogenated organics in its initial priority-setting for three principal reasons:

- A number of participants in a series of National and Regional Waste Minimization Roundtables recommended focusing on these wastes.
- Preliminary data suggest that metals and halogens in combustor feed streams contribute to emissions of metals and may contribute to the formation of some toxic products of incomplete combustion (PICs), including dioxins and furans.
- Metals and halogenated organic constituents are generally toxic, bioaccumulative, and persistent.

Therefore, to determine whether combusted wastes contain metals and halogenated organics, it was essential to identify which constituents are likely to be present in the wastestreams. Moreover, the methodology for ranking wastestreams is based not only on the presence of constituents, but also on their mass. Mass is the product of waste quantity and concentration; quantity is provided by the BRS, but concentration is not, so EPA estimated the concentration of each constituent present.

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[3]For example, a waste initially exhibiting the toxicity characteristic may be treated so that it no longer exhibits the TC, and blended with waste oils or other high-BTU materials. The resulting blended fuel would not necessarily carry the original TC waste code.

Given the difficulty and effort involved in identifying constituents and estimating concentrations, EPA decided to limit its initial waste characterization effort to the top 100 unique groups of wastestreams, by volume, that contained metals and/or halogenated organics. The combusted wastes were initially aggregated based on four key attributes: RCRA waste code set[4], standard industrial classification (SIC) code of the generator, source code of the process generating the waste (e.g., spent process liquids removal, code A37), and form code for the waste (e.g., concentrated solvent-water solution, code B201). All combusted wastestreams that were identical in terms of the four attributes were grouped together. These aggregated wastes were termed "wastestream combinations," and were ranked based on volume. EPA reviewed the composition of the 150 largest-quantity wastestream combinations to identify the top 100 containing metals and/or halogenated organics. The top 100 wastestream combinations that contain either metals or halogenated organics accounted for 1.52 million tons in 1991, or approximately 50 percent of the total quantity of routinely generated, primary combusted wastes.[5]

Information Sources

The primary sources of information for identifying constituents were the Chemical Abstract Service (CAS) numbers, RCRA codes, and waste descriptions given in the BRS. The Agency also used several other supplementary sources to identify constituents and estimate concentrations. Not all information sources were available for each wastestream, so EPA had to apply professional judgement on when to use the sources, and when to make assumptions to bridge data gaps. The major information sources are described below, in approximate order of preference.

- CAS numbers of Toxic Release Inventory (TRI) constituents. When a waste contains constituents for which the generator has submitted a TRI report, the generator must identify those TRI constituents in its biennial report. Most of the metals and halogenated organics of concern to EPA are included in the list of TRI constituents. The BRS contains this information where it was reported by the generator, but it does not provide information on constituent concentrations.

- RCRA codes. As described above, RCRA codes provide some information on the constituents present in wastestreams. The toxicity characteristic (TC) RCRA codes, D004 through D043, identify constituents present and also indicate that concentrations exceed the set of corresponding regulatory levels (expressed as concentrations measured by a leaching procedure). The P- and U-wastes (off-specification products, spill residues, and related wastes) also identify specific constituents that are present, and

[4]In the BRS, all relevant RCRA waste codes (e.g., D001 [characteristic of ignitability], F001 [spent halogenated solvents from degreasing]) that apply to a waste are reported. In some cases, 20 or more individual codes can be reported in a "code set," although it is more typical to have five or fewer codes. EPA truncated code sets at ten individual codes.

[5]Note that the Agency defines "wastes that contain metals and/or halogenated organics" to be wastes where one or more of constituents in these groups was identified as being present, regardless of the concentration. Some information sources provided information on trace constituents of wastes. For this reason, some wastes with extremely low concentrations are defined as containing metals or halogenated organics. However, hazard rankings for these wastes will reflect the low concentrations, since hazard score is directly proportional to concentration.

generally connote wastes with relatively high concentrations (unless mixed with other wastes). The K-waste (industry-specific process waste) and F-waste (generic process waste) codes can provide an indication of which constituents are present -- EPA's original waste listing decisions and its determinations of best demonstrated available technology (BDAT) for the wastes' treatment cite the constituents which are of primary concern from a risk or treatability standpoint. A list of documents providing concentration data for some of the RCRA wastes evaluated for this project appears in Appendix 4.

- Waste descriptions. For the biennial reports, generators are asked to provide descriptions for each waste they report. In some cases, these descriptions provide insight on waste constituents, although they rarely provide concentrations.

- Waste form codes. The BRS also contains a series of waste form codes that provide an indication of the physical form of the waste. These codes fall into several broad categories, including inorganic liquids, organic liquids, inorganic solids, organic solids, inorganic sludges, and organic sludges. As explained later, EPA made several assumptions on concentrations of constituents in various waste forms.

- Retrievals from the Generator Survey (GENSUR). In 1987, EPA performed an extensive survey of hazardous wastes managed as of 1986. One of the questions posed in this survey asked for information on constituents and concentrations. Although EPA recognizes that there may have been major changes in waste generation and management patterns since 1986, the GENSUR data still provide some useful information on waste composition, especially where there was a good match between the waste attributes reported in the BRS and those in the GENSUR.

  Like the Biennial Report, the GENSUR collected information on RCRA code set, waste form, the activity or process generating the waste, and the SIC of the generator. The form codes and source codes in the BRS do not correspond directly with those in the GENSUR, so EPA developed a cross-reference between the two data sets. The Agency also developed decision logic to match wastestreams from the BRS with those from the GENSUR, and retrieved data from the GENSUR to help inform the estimates of waste composition. A description of the protocol EPA used to retrieve information from the GENSUR is provided in Appendix 5.

  In addition to the GENSUR retrievals made specifically for this project, EPA used several earlier analyses of GENSUR data on D001 through D003 wastes.[6] These codes occur very frequently among the combusted wastestreams.

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[6]These previous analyses did not sort concentrations of the ignitable (D001), corrosive (D002), and reactive (D003) wastes by SIC, form code, or activity code, and thus provide a coarser degree of resolution than the more recent GENSUR retrievals. Nevertheless, where no match could be made on SIC, form, or activity, EPA used results from these analyses, which appear in two memoranda from ICF Incorporated to Ed Weiler: "Analysis of Characteristically Hazardous Waste Streams," 12/11/90, and "Analysis of RCRA Waste Stream D001-D002-D003," 10/25/90.

Approach

Using these information sources, EPA made its estimates of waste composition by applying the following methods and assumptions. The initial step involved determining which hazardous constituents are most likely to be present. Although the Agency is initially focusing its priority-setting efforts on metals and halogenated organics, for each of the top 100 combusted wastes that contain one or more of these constituents, EPA sought to identify all other important hazardous constituents as well.

Identifying constituents. The sequence for identifying hazardous constituents follows.

1) The TRI constituents and waste descriptions reported in the BRS were the preferred basis for identifying hazardous constituents. If the reported constituents could plausibly account for all of the RCRA codes reported, EPA assumed that no additional hazardous constituents were present.

2) Otherwise, the next step was to evaluate all RCRA codes in the code set, to determine which constituents were likely to be present. For the D004-D043 TC wastes, and the P- and U-wastes this was straightforward. For the listed process wastes (F- and K-wastes), this involved reviewing the documents listed in Appendix 4.

3) GENSUR data were used to identify some of the less obvious constituents, particularly if it was possible to match the BRS and GENSUR data closely, and if constituent and concentration data were available for the GENSUR match.

4) If D001, D002, and/or D003 were reported in the code set, but were not accounted for based on the constituents identified as likely to be present, EPA assumed that

- for D001, toluene, xylene, cadmium, lead, and chromium were present; these constituents were reported to be present most frequently (i.e., in more than 35 percent of all D001 wastes) across the GENSUR;
- for D002, corrosivity was due to hydrochloric acid;
- for D003, reactivity was due to sulfides (unless the form code indicated presence of reactive cyanides).

Estimating concentrations. The next step involved estimating concentrations. The primary indicators of concentration were the waste description, form code, and source code. In general, the Agency assumed that organic liquids had the highest concentrations of constituents (usually on the order of 90% organics) and aqueous liquids had the lowest concentrations (total concentration of individual constituents usually on the order of 10,000 ppm or lower). Many of the listing and BDAT documents listed in Appendix 4 provide information on compositional analyses of wastes; EPA often used these sources to estimate concentrations. EPA also used the GENSUR data, especially when there was a good match, i.e., the RCRA codes and form codes matched well.

EPA applied some assumptions to account for several of the most commonly occurring attributes:

- If the RCRA code set included D002 (corrosivity characteristic), and none of the specific constituents likely to be present accounted for corrosivity, it was generally assumed that corrosivity was due to hydrochloric acid at a concentration of about 500 ppm.
- Similarly, if the RCRA code set included D003 (reactivity characteristic), and this was not attributable to any of the specific constituents that had been identified, the Agency generally assumed that the reactivity was due to hydrogen sulfide at a concentration of 500 ppm.
- If the RCRA code set included toxicity characteristic constituents, and if there was no indication that their concentrations were relatively high, EPA assumed that the concentrations were 200 times their respective regulatory levels.[7]

Appendix 6 provides the details of the characterization effort. This attachment lists the key attributes of the 150 largest-quantity wastestream combinations. For each, it includes a check mark beside all attributes used for evaluating the constituents or concentrations. It also lists EPA's estimate of the constituents and concentrations, includes a key that indicates the presence or absence of metals and halogenated organics, and summarizes the assumptions used for the characterization. An example of the information provided in Appendix 6 appears in Exhibit 2-3.

Issue #1:	The Agency recognizes that the characterization of wastestream constituents and concentrations in this document is based on highly uncertain data, and embodies significant professional judgement. EPA invites comment from reviewers on the specific waste characterization assumptions shown in Appendix 6. Are there other readily-available sources of waste characterization data (e.g., collected by state regulatory agencies or technical assistance centers) that could be employed for hazard ranking?
Issue #2:	How might future waste characterization data be collected most efficiently, both for the purpose of setting waste minimization priorities and for measuring progress? Are there innovative approaches (e.g., partnerships with treatment, storage, and disposal facilities) that could be employed?
Issue #3:	It is difficult to track wastes that are processed by fuel blenders and subsequently combusted. Are data available on the composition of these wastes and of the blended fuels that are derived from them?

[7] As mentioned above, the form code often indicated relatively high concentrations of constituents. For example, if the form code indicated the waste is a non-halogenated solvent and the RCRA code set indicated the waste exhibited the TC for benzene, high benzene concentrations, on the order of 100,000 ppm, were assumed.

EXHIBIT 2-3. CONSTITUENT AND CONCENTRATION INFORMATION FOR EXAMPLE WASTESTREAM COMBINATIONS

RANK		RCRA waste code		SIC Code		Source Code		Form Code	Quantity	# WS	# Fac	Constituents	Conc. (ppm)	Constituent Source	Key	Assumptions
1	✓	D001 D002 U008 U113	✓	2869		A33	✓	B101	189,524	1	1	Acrylic acid	750	RCRA codes	1	Both U-waste constituents are ignitable and they are assumed to account for D001. Concentrations were based on judgement. D002 characteristic assumed because of low concentrations of organic acids in liquid. Concentration of acrylic acid based on a pH of 2 to satisfy D002 characteristic. Used Generator Survey data for wastes where the RCRA codes and SIC code matched.
												Ethyl acrylate	50,000	RCRA codes		
												Acrolein	750	Gen. Survey		
												n-Butanol	50	Gen. Survey		
												Chromium	1	Gen. Survey		
												Formaldehyde	750	Gen. Survey		
												Maleic anhydride	50	Gen. Survey		
												Phthalic anhydride	50	Gen. Survey		
2	✓	D002 D021 D028 F003 F005	✓	2879		A37		B101	130,948	1	1	Methylene chloride	20,000	BRS CAS numbers	2	F003 code assumed due to methyl isobutyl ketone and F005 code assumed due to toluene. Average concentrations for chlorobenzene and from BDAT background documents for F001-5. Concentrations for methylene chloride, ethylene dichloride, methyl isobutyl ketone, and toluene were based on judgement. Concentrations were adjusted so that total concentration of constituents was approximately 10 percent by weight for aqueous liquids. Hydrochloric acid added to constituents to account for D002 characteristic. Concentration of HCl based on a pH of 2 to satisfy D002 characteristic.
												Ethylene dichloride	10,000	BRS CAS numbers		
												Methyl isobutyl ketone	10,000	BRS CAS numbers		
												Toluene	2,000	BRS CAS numbers		
												Chlorobenzene	50,000	RCRA waste code		
												Hydrochloric acid	500	None		

2.2 DRAFT RESULTS

This section summarizes the characteristics of combusted wastes containing metals and/or halogenated organics. Section 2.2.1 provides perspective at a very broad scale, placing combusted wastes within the overall hazardous waste universe, and briefly describing some of the characteristics of the combusted waste universe (i.e., routinely generated primary waste and non-routinely generated secondary waste). Characteristics and origins of routinely generated primary combusted wastes are discussed in Section 2.2.2. Finally, in Section 2.2.3 the Agency describes the set of wastes that are evaluated in Chapter 3 -- the top 100 combusted wastestream combinations that contain metals and/or halogenated organics.

2.2.1 Overview of Combusted Wastes

About 306 million tons of hazardous waste are managed in units subject to the permitting, design, operating and maintenance, and closure requirements of Subtitle C. As shown in Exhibit 2-4, the total quantity managed in on-site and off-site incinerators and BIFs was about 3.57 million tons/year. About 0.53 million tons (or 15 percent of the total combusted wastes) are the wastes generated from the remediation and other processes as "secondary" or "one-time" wastes. Thus, after excluding secondary and one-time wastes, about 3.04 million tons of routinely generated, primary wastes are combusted at on-site and off-site facilities.

EXHIBIT 2-4

QUANTITY OF COMBUSTED HAZARDOUS WASTE BY PLACE OF MANAGEMENT AND GENERATION PATTERN

Place of Management	Quantity (million tons)		
	Routinely Generated Primary Waste	One-time and Secondary Waste	Total
On site	2.00	0.38	2.38
Off site	1.04	0.15	1.19
Total Wastes Combusted at RCRA-permitted units	**3.04**	**0.53**	**3.57**

2.2.2 Characteristics and Origins of Routinely Generated, Primary Combusted Wastes

This project focusses on setting waste minimization priorities for the set of routinely generated, primary combusted wastes, hereinafter referred to as "combusted wastes". Some of the principal characteristics of these wastes, and their origins, are summarized below.

Place of Management and Type of System

Exhibit 2-4 above shows that about two-thirds of combusted wastes were managed on site in 1991. Slightly more wastes were incinerated than burned in energy recovery systems -- the proportions are 55 percent and 45 percent, respectively. In both categories, liquids (which may include pumpable sludges) dominated the quantities managed. Liquid incineration accounted for 44.2 percent of combustion; energy recovery from liquids accounted for 40.2 percent; and thus close to 85 percent of the wastes were managed by liquid-injection based combustion systems. Sludges and solids accounted for virtually all of the remaining 15 percent.

In the two largest categories of combustors, liquid incineration and liquid energy recovery systems, information on the physical form of the wastes burned indicates that there is probably a distinction in the energy content of the wastes.

- Within the largest category of combustors, liquid incineration, aqueous waste with low solvents (B101) was the dominant waste form, comprising almost 40 percent of the liquid incineration volume. Virtually all (99 percent) of the aqueous waste solvents that are combusted are burned in liquid incineration units.

- In the other major combustor category, liquid energy recovery systems (i.e., BIFs burning liquids), the most common form of waste was unspecified organic liquids, which constituted almost one-third of the volume managed by these units. The other waste forms occurring most frequently in the liquid-burning BIFS are waste oils (12 percent) and halogenated/non-halogenated solvent mixtures (10 percent).

Waste source

The BRS contains information on the types of processes which generate each wastestream. Major categories of sources of combusted wastes in 1991 included cleaning and degreasing, surface preparation and finishing, processes other than surface preparation, and several other categories. As shown in Exhibit 2-5, three specific source categories comprised more than 50 percent of combusted wastes:

- Product distillation (A33) - 22.6 percent
- Spent process liquid removal (A37) - 16.9 percent
- By-product processing (A35) - 10.9 percent

There is a marked decrease in the quantities generated by other processes — the fourth largest process accounted for only about 2.8 percent, and an additional 19.7 percent was made up by 54 different processes. For the remaining 28 percent, the source code was not entered or could not be identified.

Waste Form

Fifty percent of the wastes combusted in 1991 were classified as organics liquids. One-fourth of the wastes were inorganic liquids. Sludges and solids accounted for most of the remaining wastes where waste form is known (12.5 percent).

Two specific waste forms dominated the combusted wastes — "other organic liquids" (B219) with 18.3 percent and "aqueous waste with low solvents" (B101) with 17.8 percent. These two waste forms accounted for 36 percent of the total combusted wastes. Exhibit 2-6 lists the proportions of combusted wastes represented by other specific form codes.

EXHIBIT 2-5

SOURCES GENERATING COMBUSTED WASTES

Volume Rank	Source Code Description	Source Code	Volume (tons)	% of Volume	Cum. % of Volume
1	Unknown	Unk	852,507	28.06	28.06
2	Product distillation	A33	687,991	22.65	50.71
3	Spent process liquids removal	A37	514,886	16.95	67.66
4	By-product processing	A35	330,244	10.87	78.53
5	Product filtering	A32	84,319	2.78	81.31
6	Product solvent extraction	A34	76,903	2.53	83.84
7	Discarded off spec material	A57	71,495	2.35	86.19
8	Other pollution control or waste treatment	A89	57,423	1.89	88.08
9	Wastewater treatment	A75	42,464	1.40	89.48
10	Clean out process equipment	A09	41,624	1.37	90.85
11	Other	A99	38,761	1.28	92.12
12	Product rinsing	A31	37,797	1.24	93.37
13	Other non-surface preparation processes	A49	33,353	1.10	94.47
14	Incineration/Thermal treatment	A74	31,069	1.02	95.49
15	Other production-derived 1-time and intermit processes	A59	17,680	0.58	96.07
16	Oil changes	A54	16,124	0.53	96.60
17	Solvents recovery	A73	15,848	0.52	97.12
18	Other cleaning and degreasing	A19	12,540	0.41	97.54
19	Filtering/screening	A71	10,332	0.34	97.88
20	Air pollution control devices	A78	6,759	0.22	98.10
	All other source codes		57,746	1.90	100.00
	Total		**3,037,866**	**100.00**	

EXHIBIT 2-6

PHYSICAL FORM OF COMBUSTED WASTES

Volume Rank	Form Code Description	Form Code	Volume (tons)	% of Volume	Cum. % of Volume
1	Other organic liquids	B219	555,704	18.29	18.29
2	Aqueous waste with low solvents	B101	541,130	17.81	36.11
3	Unknown	Unk.	378,429	12.46	48.56
4	Halogenated/non-halogenated solvent mixture	B204	216,867	7.14	55.70
5	Concentrated aqueous solution of other organics	B207	181,638	5.98	61.68
6	Waste oil	B206	152,777	5.03	66.71
7	Non-halogenated solvent	B203	152,582	5.02	71.73
8	Halogenated solvent	B202	110,706	3.64	75.38
9	Aqueous waste with low other toxic organics	B102	92,907	3.06	78.43
10	Still bottoms of non-halogenated solvents	B602	86,802	2.86	81.29
11	Concentrated solvent-water solution	B201	71,891	2.37	83.66
12	Caustic aqueous waste	B110	65,893	2.17	85.83
13	Resins	B606	38,123	1.25	87.08
14	Reactive or polymerizable organic liquid	B212	34,650	1.14	88.22
15	Other halogenated organic solids	B407	34,522	1.14	89.36
16	Other non-halogenated organic solids	B409	33,728	1.11	90.47
17	Acidic aqueous waste	B105	30,625	1.01	91.48
18	Halogenated pesticide solid	B401	27,031	0.89	92.37
19	Solid resins or polymerized organics	B403	23,150	0.76	93.13
20	Lime sludge with metals/metal hydroxide sludge	B503	22,221	0.73	93.86
21	Oil-water emulsion or mixture	B205	20,386	0.67	94.53
22	Oily sludge	B603	18,885	0.62	95.15
23	Concentrated phenolics	B208	18,639	0.61	95.77
24	Still bottoms of halogenated solvents	B601	16,273	0.54	96.30
25	Other waste inorganic solids	B319	14,374	0.47	96.78
26	Paint thinner or petroleum distillates	B211	11,752	0.39	97.16
27	Mixed lab packs	B003	7,651	0.25	97.41
28	Aqueous waste with reactive sulfides	B111	7,511	0.25	97.66
29	Soil contaminated with organics	B301	7,385	0.24	97.91
30	Organic paint or ink sludge	B604	7,205	0.24	98.14
	All other form codes		56,430	1.86	100.00
	Total		3,037,866	100.00	

Industrial Sectors

Overall, close to 400 industries (as defined by four-digit SIC codes) generated waste destined for combustion in 1991. However, as with most of the other attributes of combusted waste, much of the quantity was concentrated in a few sectors. The dominant individual sector was industrial organic chemicals (SIC Code 2869), which generated about 40 percent of the combusted waste in 1991 (see Exhibit 2-7). The next two sectors for which information was available – pesticides and agricultural chemicals (2879) and plastic materials and resins (2821) – accounted for 15 percent of the quantity, and the remaining codes accounted for less than 23 percent in aggregate.

At the broad industrial category (two-digit SIC) level, the chemical and allied product industry generated (SIC code 28) almost two-thirds of total combusted wastes. The next two industries generating the most wastes were petroleum and coal (2.6 percent) and electric, gas, and sanitary service (1.3 percent). The SIC was unknown for about 25 percent of the volume.

RCRA Waste Codes

Each wastestream is defined by all applicable RCRA waste codes. Among the combusted wastes, there were about 9,500 different combinations of RCRA codes (i.e., "RCRA code sets") in 1991. More than 450 unique RCRA waste codes occurred within these 9,500 code sets. About 8 percent of the total combustion wastes did not have a RCRA waste code.

The top five code sets accounted for about 28 percent of the total combusted quantity. The most commonly occurring individual codes were D001 (ignitable) and D002 (corrosive).

Location

Facilities located in EPA Region 6 generated and managed close to 50 percent of the combusted wastes in 1991. Regions 7, 5, and 2, which managed close to 10 percent each, were the other top three regions managing waste.

Within Region 6, Texas generated and managed approximately 40 percent of the total waste combusted in the nation, or close to 80 percent of the wastes generated and managed in Region 6. No other state generated or managed more than 10 percent of the total combusted waste. Missouri (MO), Louisiana (LA), Indiana (IN), and New Jersey (NJ) each managed more than 100,000 tons of waste, and took second to fifth places in that order for both waste generation and management.

Size Distribution of Combustion Facilities

A total of 430 facilities combusted wastes in 1991.[8] The top five facilities, each managing more than 100,000 tons, burned close to 25 percent of the combusted wastes. The top 25 facilities managed 60 percent of the wastes. Three out of the top five facilities managing the waste were located in Texas.

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[8] As of 1994, the universe of combustion facilities was smaller.

EXHIBIT 2-7

INDUSTRIAL SECTORS GENERATING COMBUSTED WASTES

Volume Rank	SIC Code Description	SIC Code	Volume (tons)	% of Volume	Cum. % of Volume
1	Industrial Organic Chemicals, N.E.C.	2869	1,147,907	37.79	37.79
2	Unknown	Unk.	752,693	24.78	62.56
3	Pesticides and Agricultural Chemicals, N.E.C.	2879	287,214	9.45	72.02
4	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	172,634	5.68	77.70
5	Pharmaceutical Preparations	2834	114,390	3.77	81.47
6	Medicinal Chemicals and Botanical Products	2833	98,137	3.23	84.70
7	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	85,652	2.82	87.52
8	Petroleum Refining	2911	78,700	2.59	90.11
9	Industrial Inorganic Chemicals, N.E.C.	2819	53,271	1.75	91.86
10	Refuse Systems	4953	31,083	1.02	92.88
11	Business Services, N.E.C.	7389	24,705	0.81	93.70
12	Photographic Equipment and Supplies	3861	21,642	0.71	94.41
13	Chemicals and Chemical Preparations, N.E.C.	2899	20,065	0.66	95.07
14	Nonclassifiable Establishments	9999	17,370	0.57	95.64
15	Synthetic Rubber (Vulcanizable Elastomers)	2822	12,289	0.40	96.05
16	Glass Containers	3221	9,038	0.30	96.34
17	Electric Services	4911	7,579	0.25	96.59
18	Paints, Varnishes, Lacquers, Enamels, and Allied Products	2851	5,788	0.19	96.78
19	Chemicals and Allied Products, N.E.C.	5169	5,559	0.18	96.97
20	Services, N.E.C.	8999	4,706	0.15	97.12
21	Manmade Organic Fibers, Except Cellulosic	2824	4,584	0.15	97.27
22	Manufacturing Industries, N.E.C.	3999	4,454	0.15	97.42
23	Wood Household Furniture, Upholstered	2512	4,341	0.14	97.56
24	Ammunition, Except for Small Arms	3483	3,658	0.12	97.68
25	National Security	9711	3,603	0.12	97.80
	All other SIC codes		66,825	2.20	100.00
	Total		**3,037,866**	**100.00**	

2.2.3 Characteristics of the Top 100 Combusted Wastestreams Containing Metals and/or Halogenated Organics

Employing the techniques described in Section 2.1.3, EPA determined which constituents were present in large-volume wastestream combinations, and identified the top 100 (by quantity) that contain metals and/or halogenated organics. It is this set of 100 wastestream combinations that is carried through to the priority-setting procedure described in Chapter 3.

EPA's waste characterization effort indicates that a wide variety of constituents are present in these top 100 wastestream combinations. As discussed earlier, the primary focus was on identifying specific metals and halogenated organics likely to be present, but EPA also attempted to identify other toxic constituents as well. Exhibit 2-8 lists the metals, halogenated organics, and other constituents identified in the top 100 wastestream combinations.

EPA identified the characteristics of the top 100 combusted wastestream combinations (ranked by amount of waste generated) that contain metals or halogenated organics. To determine the extent to which these wastestream combinations represent the universe of combusted wastes, the Agency also compared the top 100 combinations with all other combusted wastestream combinations in the BRS database (a set of 18,922). For both tasks (identifying the characteristics of the top 100 wastestream combinations, and making the comparison with other wastestreams) EPA considered (1) quantity of waste generated (in tons), (2) the form of the waste, as indicated by the form code, (3) whether the wastes are managed on site or off site, (4) the industry group generating the waste, as indicated by the SIC code, (5) the source of the waste, as shown by the source code, and (6) the RCRA waste codes represented.

EPA developed a computer program in SAS (a statistical analysis software package) to identify the characteristics of the top 100 wastestream combinations and to compare this group with the remaining combusted wastestreams. The SAS outputs provide the frequency of each form code, SIC code, etc. in (1) the top 100 wastestreams, and (2) the remaining wastestreams. The frequencies were calculated in two ways, unweighted and weighted. The unweighted frequencies do not account for the amount of waste represented by each wastestream. The weighted frequencies give more weight to instances where a given form code, SIC code, etc. is associated with a large-volume wastestream.

The analysis of the frequencies of RCRA waste codes is slightly more complex because many wastestreams contain more than one RCRA waste code. The frequency of a given RCRA waste code in the top 100 wastestream combinations is defined as (1) the number of wastestreams in which the given waste code occurs, divided by (2) the total number of occurrences of all waste codes in all of the top 100 wastestream combinations. The frequency of each waste code in the remaining wastestreams was calculated in the same manner.

The salient results of EPA's analysis are described below, for each of the characteristics examined. Only weighted frequencies are discussed and compared, because weighted frequencies reflect the amount of each type of waste.

<u>Amount of Waste Generated</u>

The top 100 wastestream combinations that contain metals or halogenated organics accounted for 50% of all the quantity of routinely generated primary combusted wastes in the BRS database. Specifically, the top 100 wastestream combinations accounted for 1.52 million tons

EXHIBIT 2-8

LIST OF CONSTITUENTS IN THE TOP 100 WASTESTREAM COMBINATIONS

Metals	Antimony Arsenic Barium Beryllium Cadmium	Chromium Copper Lead Mercury Nickel	Selenium Silver Thallium Vanadium Zinc
Halogenated Organics	1-chloro, 2,3-epoxy propane 1,1-Dichloroethane 1,1-Dichloroethylene 1,1,1-Trichloroethane 1,1,1,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1,2,2-Tetrachloroethane 1,2-Dichlorobenzene 1,2-Dichloroethane 1,2-Dichloropropane 1,2,3-Trichloropropane 1,3-Dichloropropylene 1,4-Dichloro-2-butene 1,4-Dichlorobenzene 2-Chloro-1,3-butadiene 2,3,7,8-Tetrachlorodibenzo (p)dioxin 2,4-Dichlorophenoxy acetic acid	2,4-Dichlorophenoxyacetic acid 2,4,5-Trichlorophenol 3-Chloropropene4,4-methyl ene bis(2-chloroaniline) Acetyl chloride Allyl chloride Benzal chloride Benzo trichloride Bis (2-chloroethyl) ether Carbon tetrachloride Chlorobenzene Chloroethane Chloroform Chloroprene Chloropyridine Cis 1,3-dichloropropene Dichlorobenzene Dichlorodifluoromethane	Dichloropropene Epichlorohydrin Ethylidine dichlorideHexachlorobenzene Hexachlorobutadiene Hexachlorocyclopentadiene Hexachloroethane Methyl chloride Methylene chloride o-Dichlorobenzene p-Dichlorobenzene PCBs Tetrachlorobenzene Tetrachloroethylene Trans 1,2-dichloroethene Trans 1,3-dichloropropene Trichloroethylene Trichlorofluoromethane Trichlorotrifluoroethane Vinyl chloride
Other Constituents	α-Methyl styrene 1,2,4-Trimethylbenzene 1,4-Diethylene oxide 2,4-Dimethyl phenol 2,4-Toluene diamine 2,6-Toluene diamine 2,6-Dimethyl phenol Acenaphthalene Acenaphthene Acetaldehyde Acetic acid Acetone Acetonitrile Acetophenone Acrolein Acrylamide Acrylic acid Acrylonitrile Ammonia Aniline Anthracene Benz(c)acridine Benzene Benzo(a)anthracene Benzo(a)pyrene Benzo(j)fluoranthene Bis (2-ethylhexyl) phthalate Butanol Butyl acrylate Butyl benzal phthalate Butyl benzyl phthalate Carbon disulfide Chrysene	Cresols Cumene Cumyl phenol Cyanide Cyclohexane Cyclohexanone Dibenz(a,h)anthracene Diethyl sulfate Diethylhexyl phthalate Dimethyl phthalate Diphenyl amine Diphenylamine Ethanol Ethyl acetate Ethyl acrylate Ethyl ether Ethylbenzene Ethylene glycol Ethylene glycol monoethyl ether Ethylene oxide Ethyleneimine Fluoranthene Fluorene Fluorine Formaldehyde Hydrazine Hydrochloric acid Hydrocyanic acid Hydrogen sulfide Isobutanol Isobutyraldehyde Isoheptane Isopropanol	Ketocarbamate Limonene Maleic anhydride Methanol Methyl acetate Methyl ethyl ketone Methyl isobutyl ketone Methyl methacrylate Morpholine n-Butanol Naphthalene Nitrobenzene Octamethylpyrophosphoramide Pentane Phenanthrene Phenol Phorate Phosphoroamidothioate Phosphorodithioic acid esters Phosphorothioic acid esters Phthalic anhydride Propanol Pyrene Pyridine Styrene Sulfuric acid Toluene Toluene-2,4-diisocyanate Toluene-2,6-diisocyanate Toluene diisocyanate Vinyl acetate Xylene

of waste, whereas the total amount of waste in all of the combusted wastestreams combined was 3.04 million tons.

Predominant Waste Forms

The BRS waste forms can be evaluated in terms of broad categories (e.g., organic liquids; inorganic liquids), or at a very specific level (e.g., concentrated solvent-water solution; metal scale, filings, or scrap). The predominant waste forms among the broad categories, both for the top 100 wastestream combinations and for the remaining set, were organic liquids and inorganic liquids (see Exhibit 2-9).

EXHIBIT 2-9

WASTE QUANTITY BY CATEGORY OF WASTE FORM
(Percent of Total Waste Quantity)

Waste Form	Top 100 Wastestream Combinations	All Other Wastestreams
Organic liquids (B201-B219)	46.8	54.1
Inorganic liquids (B101-B119)	35.2	14.3
Organic sludges (B601-B609)	8.4	2.8
Unknown or invalid data	5.3	19.7
Organic solids (B401-B409)	3.0	5.7
Inorganic sludges (B501-B519)	1.3	0.5
Inorganic solids (B301-B319)	0.0	2.1
Lab packs (B001-B009)	0.0	0.7
Organic gases (B801)	0.0	<0.1
Inorganic gases (B701)	0.0	<0.1
Total:	100	100

At the level of the specific waste form, the predominant forms in the top 100 wastestream combinations were substantially different from those in the remaining wastestreams. The most common in the top 100 wastestream combinations, aqueous waste with low solvents (B101), accounted for 32 percent of the quantity of these wastestreams, but only 3 percent of the remaining wastestreams. The next most common waste form in the top 100 wastestream combinations, other organic liquids (B219), accounted for 23 percent of the quantity of these wastestreams, but a substantially lower proportion (13 percent) of the remaining wastestreams.

The third most common waste form in the top 100 wastestream combinations, halogenated/nonhalogenated solvent mixtures (B204), accounted for 9 percent of these wastestreams, but only 5 percent of the remaining wastestreams.

Two waste forms were common in the remaining wastestreams that were not common in the top 100 wastestream combinations. Concentrated aqueous solutions of other organics (B207) accounted for 10 percent of the remaining wastestreams, as opposed to only 2 percent of the top 100 wastestream combinations. Non-halogenated solvents (B203) accounted for 9 percent of the remaining wastestreams but only 1 percent of the top 100 wastestream combinations.

The waste form was unknown for 5 percent of the top 100 wastestream combinations and for 20 percent of the remaining wastestreams.

On-Site vs. Off-Site Management

On-site waste management was more common for the top 100 wastestream combinations than for the remaining wastestreams, as shown in Exhibit 2-10. This is because generators of large quantities of waste can often take advantage of economies of scale and invest in the necessary equipment to manage their own wastes. For generators of smaller quantities of wastes, it is often more cost-effective to ship wastes off site for management.

Exhibit 2-10
On-Site Vs. Off-Site Management

Location of Waste Management	Top 100 Wastestream combinations	Remaining Wastestreams
On site	75 percent	57 percent
Off site	25 percent	43 percent

A more detailed presentation of the waste management options selected by the generators of the top 100 wastestream combinations is presented in Exhibit 2-11. As this exhibit shows, two-thirds of wastes managed on site were incinerated, with the remainder combusted in BIFs. Of the wastes managed off site, over 90% were combusted in BIFs.

Inorganic liquids managed on site were far more common in the top 100 wastestream combinations (accounting for 35 percent of waste quantity) than in the remaining wastestreams (where they account for only 13 percent of the wastes). Only a small amount of inorganic liquids in either set of wastestreams was managed off site. Wastes other than inorganic liquids comprised 60 percent of the top 100 wastestream combinations and 66 percent of the remaining wastestreams. In both sets, about two-thirds of the wastes other than inorganic liquids were managed on site.

EXHIBIT 2-11

SUMMARY OF QUANTITY OF TOP 100 COMBUSTED WASTESTREAM COMBINATIONS BY PLACE, TYPE, AND COMMERCIAL STATUS OF MANAGEMENT FACILITIES

Place of Management	Commercial Status	Type of Management	Waste Quantity (millions of tons)	Percent of Total Wastes
On site	Commercial	Incineration	4,565	0.3
	Non-commercial	Incineration	756,958	49.6
		BIF	382,565	25.1
		Total:	1,139,523	74.7
	Total:		**1,144,088**	**75.0**
Off site	Commercial	Incineration	24,492	1.6
		BIF	232,351	15.2
		Total:	256,843	16.8
	Non-commercial	Incineration	6,239	0.4
		BIF	117,374	7.7
		Total:	123,613	8.1
	Total:		**380,456**	**24.9**

Industrial Sectors Generating the Most Waste

Two industry groups accounted for 52 percent of waste quantity from the top 100 wastestream combinations, and 42 percent of the waste from the remaining wastestreams. Fully 37 percent of the waste in the top 100 wastestream combinations is generated by the industrial organic chemical industry (SIC code 2869). This industry generates a nearly identical proportion (38 percent) of the remaining wastestreams. Fifteen percent of the waste in the top 100 wastestream combinations is generated by the agricultural chemicals industry (SIC code 2879). This industry, however, is only responsible for four percent of the waste generated in the remaining wastestreams. No other SIC code accounts for more than 7 percent of either the top 100 or the remaining wastestreams. The SIC code was unknown for 20 percent of the top 100 wastestream combinations and for 30 percent of the remaining wastestreams.

Predominant Sources of Wastes

The predominant source codes, and their rankings, were the same for both the top 100 wastestream combinations and the remaining wastestreams. The most common source was product distillation (source code A33), accounting for 29 percent of the top 100 wastestream combinations and 16 percent of the remaining wastestreams. The next most common source was spent process liquids removal (source code A37), accounting for 22 percent of the top 100 wastestream combinations and 12 percent of the remaining wastestreams. The third most common source was by-product processing (source code A35), accounting for 14 percent of the top 100 wastestream combinations and 8 percent of the remaining wastestreams. No other waste source accounted for more than 5 percent of either set of wastestreams. The waste source was unknown for 23 percent of the top 100 wastestream combinations and for 33 percent of the remaining wastestreams.

RCRA Waste Codes

The most common RCRA waste codes were the same in both the top 100 wastestream combinations and the remaining wastestreams, with one exception. The most common waste codes, and their respective percentages for the top 100 wastestream combinations and the remaining wastestreams, are as follows:

- D001, ignitable waste (20 percent and 27 percent),
- D002, corrosive waste (13 percent and 10 percent),
- F002, certain spent halogenated solvents and still bottoms (7 percent and 3 percent),
- F003, certain spent non-halogenated solvents and still bottoms (6 percent and 8 percent), and
- F005, certain spent non-halogenated solvents and still bottoms (6 percent and 4 percent).

The one RCRA waste code that was significantly more common in the remaining wastestreams is D018, toxicity characteristic for benzene, which accounted for only 2 percent of the top 100 wastestream combinations but represented 8 percent of the remaining wastestreams.[9]

Locations

Exhibit 2-12 shows the quantities of wastes in the top 100 wastestream combinations generated in each state. As the exhibit shows, two states (Texas and Missouri) account for more than half of these wastes (43 percent and 14 percent respectively).

Wastes Requiring Further Study

EPA has experience in developing waste minimization strategies for routinely generated wastes where the source is a well-defined, integral part of a production process. There are several types of wastes among the top 100 that are either not well-defined (e.g., there are missing data) or are not part of production processes where waste minimization opportunities involve direct intervention or modification in the process. These include:

- Waste treatment residues (source code A75)
- Air pollution control device residues (source code A78)
- Other pollution control or waste treatment residues (source code A89)
- Other source (source code A99)
- Source code not listed
- Still bottoms of halogenated solvents or other organic liquids (B601)

[9] The wastestreams in the top 100 wastestreams that contain benzene also contain a metal or halogenated organic waste.

EXHIBIT 2-12

TOP 100 COMBUSTED WASTESTREAM QUANTITIES BY REGION AND STATE (for states with generation exceeding 1,000 tons in 1991)

Region	State	Quantity (tons/yr)	% of Total
1	CT	3,785	0.20
	MA	1,401	0.10
2	NJ	70,227	4.60
	NY	14,949	1.00
	PR	32,115	2.10
3	DE	3,513	0.20
	MD	2,786	0.20
	PA	51,551	3.40
	VA	23,538	1.50
	WV	5,328	0.30
4	AL	12,907	0.80
	FL	7,521	0.50
	GA	6,897	0.50
	KY	20,009	1.30
	NC	4,501	0.30
	TN	23,040	1.50
5	IL	5,817	0.40
	IN	88,354	5.80
	MI	60,144	3.90
	OH	63,347	4.20
	WI	21,045	1.40
6	AR	16,491	1.10
	LA	87,510	5.70
	TX	681,063	44.70
7	MO	173,125	11.40
9	CA	40,781	2.70
	Other states	1,776	0.12
	Total:	**1,523,521**	**100.00**

- Still bottoms of non-halogenated solvents or other organic liquids (B602)

To the extent that these wastes could be identified as high-priority wastes for minimization, they would require more detailed study (and potentially a better understanding of "upstream" processes) than most other waste categories.

Exhibit 2-13 identifies the quantities and percentages of these wastes in the top 100 combusted wastestream combinations containing metals and/or halogenated organics. As this exhibit indicates, 35 percent (by quantity) of the top 100 combusted wastes would require additional study in order to evaluate waste minimization. The dominant category within this set is "Blank or Unknown Process," corresponding to BRS records where the process was not identified by the generator or could not be tracked based on the linking of the GM and WR data sets.

EXHIBIT 2-13

WASTES REQUIRING FURTHER STUDY

Waste Category	Quantity (tons)	Percent of Top 100 Combusted Wastestream Combinations
Waste treatment (A75)	33,892	2.2
Air pollution control devices (A78)	0	0
Other pollution control or waste treatment (A89)	42,805	2.8
Still bottoms of non-halogenated solvents or other organic liquids (B602)	71,545	4.9
Still bottoms of halogenated solvents or other organic liquids (B601)	13,073	0.9
Other (A99)	18,000	1.2
Blank or Unknown process	353,478	23.2
Subtotal	532,793	35.0
Subtotal other wastes	990,728	65.0
Total "Top 100" Combusted Wastestream Combinations	1,523,521	100.0

Summary of Comparison

EPA compared the top 100 wastestream combinations with all other wastestreams in order to assess whether the top 100 were representative of combusted wastes generally. EPA found that there were some potentially significant differences between these two groups of wastes, which could indicate directions for follow-up waste characterization work. In sum, the characteristics of the top 100 wastestream combinations differ from the characteristics of the remaining combusted wastestreams, in that the top 100 wastestream combinations have

- a <u>much</u> higher average quantity per wastestream;
- a much higher proportion managed on site;
- a lower proportion of organic liquids and higher proportion of inorganic liquids. In particular, the top 100 have a much higher proportion of aqueous waste with low solvents (B101), a substantially higher volume of "other" organic liquids (B219), and a substantially lower volume of (1) concentrated aqueous solutions of other organics (B207) and (2) non-halogenated solvents (B203); and

> Issue #4: EPA solicits comments from reviewers on whether certain types of combusted wastes should be the focus of future waste characterization efforts. If so, for which types of wastes? How could this data be most efficiently collected?

- more complete data (i.e., fewer blanks and unknowns in the data set) -- this difference means that all of the above comparisons are subject to uncertainty, particularly if there may be a systematic bias such that wastestreams with certain characteristics may have been more likely to have missing data.

2.3 LIMITATIONS

This section lists and briefly discusses some of the limitations of the data used for this analysis.

Biennial Reporting System Data Limitations:

- <u>Most recent comprehensive data available on waste generation and management are from 1991.</u> Significant changes in waste management practices are believed to have taken place since 1991. Using 1991 data does not address the potentially significant changes in waste management practices between 1991 and 1994 due to: land disposal restrictions (LDRs) for Third Third wastes, Phase 1, and Phase 2 wastes; expiration of capacity variances; other federal regulations; changes in economic conditions; and increasing awareness of environmental liabilities. As one example of an important change, the quantity of wastes exhibiting the toxicity characteristic (TC) for organics, and managed in incinerators or BIFs, would have increased since 1991 because of LDRs. As a result, the characterization of the universe of combusted wastestreams is a rough approximation.
- <u>Data used in this analysis do not reflect recent State updates.</u> EPA wanted to make the Phase I methodology document available for public review as quickly as possible. Consequently, revised 1991 data submitted by States in June 1994 as part of the

Capacity Assurance Planning process could not be reflected in the document. EPA plans to utilize the updated State data when finalizing the Phase I document.

- Data were missing for some key data fields. Data were missing for some of the key data fields used in the analysis. Missing data for these elements, along with unreported generator and/or receiver facility IDs for facilities, made it difficult to map data from the GM Forms to the WR Forms. This limited EPA's ability to determine the origins of the wastes, and also made it difficult to characterize constituents and concentrations. The quantity of waste for which key information was missing or invalid is as follows:

Waste Quantities with Missing or Invalid Information, by Attribute

Attribute	Percent of Waste Quantity with Missing Data	
	All Combusted Wastes	Top 100 Wastestream Combinations with Metals and/or Halogenated Organics
Source/Process Code	28.1	23.2
SIC Code	24.8	19.9
Form Code	12.5	5.3
Waste Code	8.2	6.1
Missing one or more Codes	35.6	0.0

Note that process code and SIC code are the elements missing most frequently. This is due primarily to the large set of "unmatched" off-site wastes.

Constituent Concentration Data Limitations

- **Constituent content and concentration estimates are rough approximations.** There is significant variability in the constituent content and concentrations of specific hazardous wastestreams over time and across generators within an industrial sector. EPA has developed point estimates of wastestream concentrations, for national screening purposes, which can only roughly approximate the true range of concentrations for particular wastestreams.

- **Generator Survey and other sources may not be current.** EPA used the most recent constituent content and concentration data available. However, many of the sources of data (e.g., the Generator Survey and some of the listing background documents) are at least five years old. Consequently, the wastestreams characterized and their constituent content and concentrations may not correspond completely to current waste characteristics. The extent and direction of this error is unknown. The Agency welcomes any data from commenters that would help to update the waste characterization data used here.

- **Generator Survey data likely to be more accurate for metals than for organics.** The Generator Survey was designed to capture information on both metals and organics, however, the survey format made it harder for respondents to supply information on organics. In general, the Generator Survey data are probably more accurate for metals than for other constituents. Wastestream combinations where the Generator Survey was used as an information source for identifying constituents may overstate the occurrence of metals, and understate the occurrence of organics.

CHAPTER 3
PRIORITIZING WASTESTREAMS AND THE INDUSTRIAL PROCESSES GENERATING THEM

This chapter presents the methodology and results of EPA's effort to prioritize hazardous wastestreams and the industrial processes generating these wastestreams. The first section of this chapter discusses in detail the development of the hazard-based prioritization system. The second section presents a summary of the results from the prioritization exercise, and the final section outlines limitations of the system and the data used for the analysis. Highlighted throughout this chapter are certain key issues pertaining to the prioritization methodology; the Agency is soliciting comments from reviewers on these issues.

3.1 METHODOLOGY

3.1.1 Considerations Relevant to the Prioritization System

A number of the considerations that were important in developing the system for prioritizing hazardous wastes are discussed below.

<u>Addressing the goal of RCRA Waste Minimization National Plan (RWMNP)</u>. As discussed in Chapter 1, the stated goal of the RWMNP is to reduce the quantity and toxicity of hazardous waste through source reduction and then recycling (where source reduction is not feasible). This goal indicates a focus on the hazard of wastes *as generated* (i.e., prioritization based primarily on the characteristics of the waste prior to management).

<u>Focusing on combusted wastestreams as part of Phase I of the RWMNP</u>. Phase I of the RWMNP addresses hazardous wastes managed in combustion units.[1] This indicates a focus on the hazard of wastes *as managed* (e.g., examining the releases from combustion units and potential exposures).

<u>Addressing recommendations made during the November 1993 National Roundtable discussions on waste minimization and combustion</u>. Relevant recommendations included setting priorities based on risk; adopting a multi-media approach that considers risks via all media; focusing on persistent, toxic, and bioaccumulative constituents in wastestreams (e.g., metals and halogenated organics); and encouraging movement up the waste management hierarchy (with a clear preference for source reduction).[2]

<u>Meeting an ambitious schedule for Phase I of RWMNP</u>. Phase I of the RWMNP (which coincides with the waste minimization portion of the Hazardous Waste Minimization and Combustion Draft Strategy) is scheduled to begin implementation this fall. This meant that an

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[1] Phase II of the RWMNP will go beyond hazardous wastes managed in combustion units to set priorities for wastes managed by other practices.

[2] The waste management hierarchy, described in the Hazardous and Solid Waste Amendments (HSWA) and elsewhere, lists source reduction as the most preferred management option, followed by environmentally sound recycling, treatment, and, finally, disposal.

approach had to be developed quickly, preferably using an existing methodology that had undergone some level of peer review. Furthermore, the approach had to be implementable using readily-available data.

Selecting from a broad array of potential criteria that could be included in a prioritization system. There are a significant number of prioritization criteria that could be considered, including the following:

Risk/hazard-based criteria

- ✓ Waste quantities
- ✓ Waste characteristics (e.g., constituent concentrations and physical/chemical properties)
- ✓ Waste management practices (e.g., combustion)
- ✓ Constituent releases
- ✓ Fate and transport
- ✓ Human and ecological exposure
- ✓ Human and ecological toxicity

Other criteria

- ✓ Protection of natural resources (e.g., stratospheric ozone and ground water)
- ✓ Demand for waste management capacity
- ✓ Environmental justice concerns
- ✓ Environmental compliance record
- ✓ Technical/economic feasibility of promoting waste minimization
- ✓ Quality of life

In addition, there are different ways of aggregating and weighting the criteria. EPA desired to develop an approach that would be suitable for national screening purposes and that would be applicable not only to combusted wastestreams, but to wastestreams managed by other practices as well.

Developing a national screening tool that could potentially be understood and adapted for use by EPA regions and state environmental agencies. EPA's national screening of wastestreams can be viewed as just the first step in a continuing process of identifying and refining priorities for waste minimization. Regions and states will likely refine wastestream rankings based on better data and their own priorities.

3.1.2 Balancing the Considerations

EPA attempted to balance the considerations discussed above in developing a system for prioritizing hazardous wastes. In reviewing potentially applicable EPA and State prioritization methodologies (discussed in the next section), the Agency focused first on approaches that would rank wastes based on their hazard as generated, in keeping with the broad goal of the RWMNP to reduce the quantity and toxicity of hazardous wastes. In examining the hazard of wastes as generated, the Agency's objective was to identify and promote source reduction for wastes that are the most pervasive, toxic, mobile, persistent, and/or bioaccumulative, considering the major environmental pathways of contaminant transport and exposure (air, surface water, ground water, soils, and the food chain). This approach would potentially reduce not only the generation of hazardous wastes, but the release of toxic constituents to all media and the subsequent exposures of workers, the general public, and ecological receptors.

A secondary consideration in developing EPA's system for prioritizing wastes was to identify wastes that would potentially pose the greatest risks when burned in combustion units, in keeping with the focus of Phase I of the RWMNP on combusted hazardous wastes. EPA did not attempt to actually estimate releases, exposures, and risk/hazard from combustion units (i.e., risk/hazard from wastes as managed) for the purpose of ranking wastestreams due to the following reasons: the significant data requirements and apparent lack of screening methodologies to do this; the short schedule for Phase I of the RWMNP; and the fact that regions and/or states would potentially be better able and more suited to conduct these analyses. Instead, the Agency decided to focus on the characteristics of combusted wastestreams, focusing in particular on wastestreams containing metals and/or halogenated organic compounds.

A number of participants at the National Roundtable expressed particular concern about combustion of wastes containing metals and halogenated organic compounds. Metals are a concern because they are not destroyed during combustion and typically end up in ash, releases to air, and/or products (e.g., cement). All metals are persistent, and some are toxic and/or bioaccumulative. Some metals (e.g., copper) are also believed to act as catalysts in the synthesis of dioxins during combustion. Halogenated organic compounds are a concern since they may contribute to formation of dioxins during combustion. Aside from the potential for reduced risks from combustion, there may be other multimedia benefits from reducing the generation of halogenated organic-containing wastestreams, since some halogenated organics have been associated with depletion of stratospheric ozone and others have been liked with special ground-water remediation problems. Furthermore, some halogenated organics do not degrade readily in the environment and tend to exhibit high human and ecological toxicities. Halogenated organics are also prominent on lists of "persistent bioaccumulators" that have been derived for various prioritization purposes.

As mentioned above, another important consideration in examining potentially-applicable prioritization methodologies included developing an approach quickly -- preferably using an existing methodology that had undergone some level of peer review. Finally, given that many current regional and state ranking systems are based on just a few prioritization criteria (e.g., waste quantity, constituent toxicity, and/or waste management capacity shortfalls), the Agency wanted to limit the number of criteria considered and the complexity of the methodology. Some of the key issues related to the development of the prioritization scheme are listed in the following text box.

Issue #5: **Considerations and prioritization criteria relevant to developing a prioritization methodology.** EPA solicits comments from reviewers on which considerations or prioritization criteria should be emphasized in developing a prioritization system.

Issue #6: **Emphasis on hazard of wastes *as generated*.** EPA also requests comments on the appropriateness of emphasizing the hazard of wastes *as generated* in developing a national-level screening methodology for prioritizing hazardous wastes.

Issue #7: **Focus on combusted wastestreams containing metals and/or halogenated organics.** Should the focus of the methodology, for Phase I of the RWMNP, be on setting priorities for combusted wastestreams containing metals and/or halogenated organics? Should combusted wastestreams containing neither metals nor halogens be addressed as well?

Issue #8: **Applicability of as-generated, hazard-based methodology to combusted wastestreams containing metals and/or halogenated organics.** Given that metals are not destroyed by combustion (and typically exit the combustion unit in ash, air releases, or product), is an as-generated, hazard-based methodology appropriate for national screening of wastestreams containing metals? Is it appropriate for wastestreams containing halogenated organics, or should the methodology be modified to better reflect the hazard of these compounds as managed (e.g., through applying a destruction and removal efficiency (DRE) factor to halogenated organics concentrations in wastes, prioritizing based on percent halogen in waste feedstocks, focusing on wastestreams containing dioxin precursors, or using another approach)? Should the approach be complemented by addressing releases/transfers reported in the Toxics Release Inventory (TRI)?

3.1.3 Review of Existing Screening, Ranking, and Prioritization Systems

As a first step toward developing a prioritization system suitable for the RWMNP, EPA reviewed and summarized 13 existing systems or methods for screening, ranking, and/or prioritizing chemicals, wastes, or problem areas (see Exhibit 3-1). Following the review and summary, EPA evaluated the purposes of the various systems and their suitability for use in support of prioritization for waste minimization.

This section briefly discusses the purposes of these 13 existing screening, ranking, and/or prioritization methods, and their suitability for use in EPA's waste minimization prioritization process. Summaries of these methods are provided in Appendix 7.

Purposes of the Methods Reviewed. The 13 screening, ranking and/or prioritization methods were selected for review because they prioritized chemicals, wastes, or problem areas based on potentially-applicable criteria. Each of these methods was developed for a distinct purpose, and accordingly, each considered a different subset of chemicals, wastes, or problem areas. The purposes of the various methods ranged from prioritizing treatment, storage, and disposal facilities for possible corrective actions (National Corrective Action Prioritization System) to targeting 17 chemicals for a pollution prevention challenge program (the EPA 33/50 program).

Applicability to the Waste Minimization Prioritization Process. The various methods, in addition to having different purposes, also considered slightly different sets of screening/ranking criteria, were based on different levels of scientific rigor, and relied on different types of data. After reviewing these methods, EPA concluded that none is suitable for use as the prioritization system for the RWMNP without some modifications. Most of the methods were screened out for one or more reasons; examples of why methods were screened out include the following:

- The Numerical Hazard Ranking Scheme for Waste Scheduling does not consider waste quantity or ecological toxicity;
- The Existing Chemicals Screening Program approach is resource-intensive and is based on the consensus of experts regarding the riskiest chemicals rather than a quantitative analysis that could be extended to additional constituents; and
- The Risk-Based Enforcement Strategy does not consider exposure potential as a criterion in scoring and ranking.

Issue # 9: Other applicable prioritization systems. Are there other methodologies in use in the United States or in other countries that could be readily applied to prioritizing hazardous wastestreams?

On balance, based on the considerations discussed earlier, EPA determined that the Superfund Hazard Ranking System, or HRS, is the most suitable existing scoring/ranking method to be adapted for use as a waste minimization prioritization system for RWMNP.[3] The HRS has three major advantages: (1) it addresses numerous hazard-related criteria in four pathways to develop an

[3] The final HRS model has been published in *40 CFR Part 300 Hazard Ranking System; Final Rule, 55 Federal Register 51532, December 14, 1990.*

Exhibit 3-1
Existing Screening, Ranking, Prioritization Systems Reviewed

System	Agency/Office
Arizona Waste Minimization Project Screening Process	EPA Office of Waste Programs Enforcement (Region IX)
Chemical Use Clusters Scoring Methodology	EPA Office of Pollution Prevention and Toxics
EPA 33/50 Program Targeting Process	EPA Office of Pollution Prevention and Toxics
EPA Regional Comparative Risk Ranking Program	EPA Office of Policy Planning and Evaluation
Existing Chemicals Screening Program	EPA Office of Pollution Prevention and Toxics
Industrial Pollution Prevention Opportunities for the 1990's Screening Process	EPA Office of Research and Development
National Corrective Action Prioritization System (NCAPS)	EPA Office of Solid Waste
Nonhazardous Industrial Waste Targeting and Pollution Prevention Project	Minnesota Office of Waste Management
Numerical Hazard Ranking Scheme for Waste Scheduling	EPA Office of Solid Waste
Risk-Based Enforcement Strategy (RBES)	EPA Office of Health and Environmental Assessment
Superfund Hazard Ranking System (HRS)	EPA Office of Solid Waste and Emergency Response
Toxics Release Inventory (TRI) Environmental Indicators Methodology	EPA Office of Pollution Prevention and Toxics
Toxics Release Inventory Risk Screening Guide	EPA Office of Pollution Prevention and Toxics

assessment of threats to humans and the environment; (2) it is among the most carefully developed and most widely applied targeting schemes that is relevant to wastes; and (3) it is the most thoroughly peer-reviewed targeting scheme among those reviewed (having been reviewed by the EPA Science Advisory Board and the National Academy of Sciences). Furthermore, EPA determined that the HRS could be applied quickly because it required limited modifications and relied on readily-available data (e.g., hazard-related data had already been compiled in the *Superfund Chemical Data Matrix* or *SCDM*).

3.1.4 Prioritization System Developed Based on the HRS

EPA determined that, at a minimum, the desired prioritization system had to reflect hazard-based rankings of the wastestreams; therefore, it needed to consider both inherent toxicity and potential for exposure, i.e., each wastestream had to be scored based on criteria related to toxicity and exposure potential. For waste minimization prioritization, the toxicity criterion is meant to measure the inherent threat of a particular wastestream, i.e., the potential for its constituents to cause adverse effects to human and ecological receptors in the event of exposure (e.g., during handling or through combustion emissions). The exposure potential criteria are meant to measure the extent to which the waste's constituents may be released to the environment (reflected by waste quantity) and the potential for its constituents to be mobile, to persist in the environment, and to accumulate in plant and animal tissue, potentially leading to exposures.

The Agency determined that the *waste characteristics* factor category of the HRS provided a suitable foundation for modeling the human and ecological toxicity and exposure potential of hazardous wastes via several pathways. EPA modified the HRS waste characteristics factor category slightly in developing the methodology for prioritizing wastestreams for waste minimization (referred to as the "modified HRS approach" below), in order to better discriminate between hazardous wastestreams. Differences between the modified HRS approach and the HRS waste characteristics factor category (the "original HRS approach") are discussed below after presentation of the modified HRS approach.

Modified HRS Approach for Scoring and Ranking Wastestreams

Steps in the modified approach for scoring wastestreams can be summarized as follows:

Step 1: Estimate Constituent Mass. Based on concentration of each constituent (in ppm) and the volume of the wastestream, estimate the mass of each constituent in units of pounds.

Step 2: Determine Constituent Pathway Score. Select the highest pathway score for the constituent, reflecting the most hazardous pathway or threat. The pathways and factors used to derive the pathway scores are shown in Exhibit 3-2.

Step 3: Calculate Constituent Hazard Score, using the following formula:

$$\text{Constituent hazard score} = \text{Constituent mass} \times \text{Constituent pathway score}$$

Step 4: Determine Wastestream Hazard Score. Select the highest among the constituent hazard scores as the wastestream hazard score.

Relationship of Modified HRS Approach to Original HRS Approach

EPA's modified approach relies on the factors and pathway scores that have been developed as part of the HRS algorithm. In its complete form, the HRS model is used for scoring abandoned hazardous waste sites by evaluating four pathways, i.e., ground water migration, surface water migration, and soil exposure. (The surface water and soil pathways consist of "subpathways" or "threats" that are scored where relevant.) Each of these pathways is scored based on three primary criteria called "factor categories," one of which is waste characteristics.[4] Individual scores are assigned to each of these factor categories based on a number of subcriteria,

[4] Two other factor categories - likelihood of exposure/release and targets - were not employed in EPA's modified approach for prioritizing wastestreams.

Exhibit 3-2
Factors Used to Calculate Pathway Scores

Pathway	Factors for Calculating Pathway Score[a]
Ground Water Migration Pathway	► Toxicity * Mobility
Surface Water Migration Pathway	<u>Drinking Water Threat</u> ► Toxicity * Persistence ► Toxicity * Persistence * Mobility[b] <u>Human Food Chain Threat</u> ► Toxicity * Persistence * Bioaccumulation ► Toxicity * Persistence * Mobility[b] * Bioaccumulation <u>Environmental Threat</u> ► Ecosystem Toxicity * Persistence * Bioaccumulation ► Ecosystem Toxicity * Mobility[b] * Persistence * Bioaccumulation
Soil Exposure Pathway	► Toxicity
Air Migration Pathway	► Toxicity * Mobility

[a] The term "pathway score" corresponds to the *toxicity/combined factor* value derived in the original HRS.
[b] Mobility is included whenever a ground water-to-surface water pathway is relevant.

called "factors". The *waste characteristics factor category* includes the following factors:

- Hazardous waste quantity factor
- Human or ecological toxicity factors
- Mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factors.

The *hazardous waste quantity factor* is evaluated and used individually. The remaining factors, although evaluated individually, can be combined mathematically to obtain "combined" factor values. For example, although toxicity, mobility, and persistence are evaluated individually, the factor values can be combined mathematically to obtain a *toxicity/combined factor* value.

The relationship between the elements in EPA's modified HRS approach and the elements in the original HRS approach is indicated below, along with key differences:

This element in EPA's modified approach . . .	. . . is analogous to this element in the original HRS approach
Constituent mass	Hazardous waste quantity factor. The hazardous waste quantity factor value in the original HRS is based on the mass of all constituents <u>combined</u>; the value is assigned based on which range of mass values (as determined from a table in the HRS) the combined mass falls in.
Pathway score	Toxicity/combined factor value. The toxicity/combined factor value is used without modification as the constituent pathway score in EPA's modified HRS approach.
Constituent hazard score	There is no direct analog in the original HRS, which estimates hazard based on total mass across constituents and highest pathway value rather than calculating a value for each constituent.
Wastestream hazard score	Waste characteristics factor category value. The waste characteristics factor category value in the original HRS approach is calculated by multiplying the hazardous waste quantity factor value times the highest toxicity/combined factor value across <u>all</u> constituents in the waste (i.e., the combined mass of all constituents in the waste is multiplied times the highest pathway score for any constituent in the waste). EPA modified this approach for prioritizing hazardous wastestreams so that constituents with very high toxicity/combined factor scores but very low mass (e.g., mercury) would not tend to artificially dominate wastestream rankings.

In both the modified approach and the original HRS approach, each of the factors (i.e., [human] toxicity, ecosystem toxicity, persistence, mobility, bioaccumulation potential, and ecosystem bioaccumulation potential) are evaluated individually based on a constituent's properties. Procedures for evaluating the factors and the types of data considered are explained in the HRS Final Rule;[5] a brief summary is presented in Exhibit 3-3. Factor values derived based on constituent properties can then be combined mathematically to obtain combined factor values. HRS pathway scores that EPA used for the prioritization approach are listed in Appendix 8.

<u>Scoring and Ranking Industrial Processes</u>

EPA also modified the HRS-based scoring approach to score and rank industrial processes generating the priority hazardous wastestream combinations. EPA calculated a score for each wastestream combination, defined by a unique combination of RCRA code set, waste form, SIC of generator, and source. The Agency then summed the hazard scores for each individual SIC Code/Source Code combination to derive the SIC/source hazard score. Then, EPA ranked the unique SIC Code/Source Code combinations according to the derived scores. In essence, the

[5] *40 CFR Part 300 Hazard Ranking System; Final Rule, 55 Federal Register 51532, December 14, 1990.*

EXHIBIT 3-3

DERIVING FACTOR VALUES IN THE HRS

Toxicity

- The *human toxicity factor* values for hazardous constituents are established based on cancer slope factors (SFs) and the carcinogenic weight-of-evidence classification, noncancer reference doses (RfDs), and where appropriate, acute LC_{50}s and LD_{50}s (see Table 2-4 in *55 Federal Register 51532* for values to be assigned to the *toxicity factor*).

- The *ecosystem toxicity factor* value is assigned for the constituent from Table 4-19 in *55 Federal Register 51532* based on the following data hierarchy:

  - EPA chronic Ambient Water Quality Criteria (AWQC);
  - EPA chronic Ambient Aquatic Life Advisory Concentrations (AALAC);
  - EPA acute AWQC;
  - EPA acute AALAC; or
  - Lowest LC_{50} value for the constituent.

Mobility, Persistence, and Bioaccumulation/Ecosystem Bioaccumulation Potential

- A *ground water mobility factor* value is assigned to each constituent (for the specific type of aquifer being evaluated) based on its water solubility and distribution coefficient (K_d). (Inorganic constituents are evaluated based on K_ds only.) Table 3-8 in *55 Federal Register 51532* lists *mobility factor* values that correspond to the water solubility and K_d values. An *air mobility factor* value for gaseous hazardous substances is derived based on vapor pressure (see Table 6-11 in *55 Federal Register 51532* for assigning the *air mobility factor* values).

- The *persistence factor* is assigned a value based primarily on the half-life of the hazardous constituent in surface water and secondarily on the sorption of the constituent onto sediments (see Table 4-10 in *55 Federal Register 51532* for correspondence between half-lives and the *persistence factor* score). The half-life in surface water is defined as the time required to reduce the initial concentration in surface water by one-half as a result of the combined decay processes of biodegradation, hydrolysis, photolysis, and volatilization.

- The *human bioaccumulation potential factor* value is derived for each constituent based on the following data hierarchy: (a) bioconcentration factor (BCF) data; (b) log K_{ow} data; or (c) water solubility data. Only data relevant to aquatic food chain organisms are used. The factor value is assigned according to Table 4-15 in *55 Federal Register 51532.*

- The *ecosystem bioaccumulation potential factor* is evaluated in the same way as the *bioaccumulation potential factor*, with two exceptions:

  - BCF data for all aquatic organisms (not just aquatic human foodchain organisms) are used; and
  - BCF data that correspond to the type of water body in which the sensitive environments are located are used.

score for each SIC Code/Source Code combination reflects the hazard of all the wastestream combinations (that are assigned hazard scores in the preceding exercise) that it generates.

3.2 DRAFT RESULTS

This section describes the draft results from the scoring and ranking analysis, first on the basis of wastestream combinations, and then aggregated based on origins of the wastes. Note that hazard scores are represented by very large numbers (e.g., the highest score is 7.1×10^{13}). The numeric hazard scores do not correspond to any absolute measure of the magnitude of hazard or risk; only the relative difference between the scores is significant (see also the limitations discussion).

3.2.1 Scores and Ranks for Wastestream Combinations

The list of top 100 wastestream combinations, ranked by their hazard scores is presented in Exhibit 3-4. For each wastestream combination, the exhibit also shows the constituent on which the hazard score is based ("hazard-driving constituent"), and the rank for each wastestream combination based on waste quantity alone. The range of scores is quite broad, from about 5.1E+06 to 7.1E+13,[6] and the total hazard score (i.e., the sum of the wastestream hazard scores across all 100 wastestream combinations) is 1.9E+14. The results in Exhibit 3-4 illustrate three key points:

(1) Most of the hazard -- almost 85 percent of the total hazard score -- is accounted for by the top five wastestream combinations. Three of these five wastestream combinations belong to SIC 2869 (Industrial Organic Chemicals) and Source Code A33 (Product Distillation);[7]

(2) Although there is a very large range in the scores (almost seven orders of magnitude), 73 of the 100 fall within a two order of magnitude range, between 1E+10 to 1E+12.[8] Thus, as measured by the scoring system, there is a fairly large set of wastes with a similar degree of hazard, and smaller sets of relatively high-hazard and low-hazard wastes that are distinctly different;

(3) The hazard of a given wastestream combination is not driven by waste quantity alone, but reflects both the waste quantity and the hazard of the waste constituents. The "volume rank" column in Exhibit 3-4 shows that the five top-ranked wastestream combinations are not the top "volume-drivers," and the highest quantity wastestream combination ranks as No. 17 in terms of hazard.

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[6] For scientific notation, this report uses a convention used frequently in computer programming, i.e., the digits following a capital E represent the exponent to the power of 10. For example, 2E+02 represents 2×10^2, or 200.

[7] Appendix 2 presents BRS code descriptions for all codes used in the BRS data forms.

[8] In fact, the scores appear to exhibit a log-normal distribution, with the geometric mean close to the median score (8.7E+10).

EXHIBIT 3-4

TOP 100 WASTESTREAM COMBINATIONS, RANKED BY HAZARD SCORES

Rank	Wastestream Combination	SIC Code	Source Code	Form Code	Volume (Tons)	Hazard-Driving Constituent	Wastestream Combination Score	Cum. Percent	Volume Rank
1	D001 F001 F002 F003 F005 U001 U002 U003 U019 U028	2869	A33	B219	14,217	Bis (2-ethylhexyl) phthalate	7.09E+13	37.15%	41
2	D002 D006	2833	A32	B207	3,724	Cadmium	3.72E+13	56.64%	125
3	K022	2869	A33	B606	23,281	Fluoranthene	2.32E+13	68.79%	24
4	D001 D002 D019 D032 D033 D034 D039 F002	2869	A33	B219	3,866	Hexachlorobutadiene (hexachloro-1,3-buta	1.93E+13	78.91%	122
5	D001 D007 D008 D018 D022 D026 D027 D028 D033 D036	9999	A99	B219	7,001	Hexachlorobutadiene (hexachloro-1,3-buta	1.05E+13	84.41%	71
6	D001 D002 D003 F002 F020 F024 K017 K018 K020 K028	2821	A37	B219	48,039	Tetrachlorobenzene	4.79E+12	86.92%	9
7	F003 F005	Unkwn	Unkwn	B219	17,218	Mercury	2.58E+12	88.27%	34
8	D001 D008 F003 F005	4953	A73	B203	4,880	Lead	2.43E+12	89.54%	98
9	D001 D002	2869	A31	B207	3,873	Hexachlorocyclopentadiene	1.93E+12	90.55%	121
10	Unknown	Unkwn	Unkwn	B206	84,191	Benzo(a)anthracene	1.68E+12	91.43%	5
11	D001 D002	2869	A35	B219	95,042	Aniline	1.42E+12	92.18%	4
12	D001 D018 D019 D039 F024	2869	A74	B202	26,708	Hexachlorobutadiene (hexachloro-1,3-buta	1.33E+12	92.87%	20
13	D001 D028 F037 F038	2911	A89	B205	6,785	Benzo(a)anthracene	6.77E+11	93.23%	75
14	K002	2865	A33	B203	6,554	Lead	6.54E+11	93.57%	79
15	D001 D005 D006 D007 D008 D018 D026 D035 F001 F002	Unkwn	Unkwn	B219	31,348	Cadmium	6.26E+11	93.90%	17
16	D019 D022 D032 D039 D043 K018 K020	2869	A33	B219	3,132	Hexachlorobenzene	6.25E+11	94.23%	139
17	D001 D002 U008 U113	2869	A33	B101	189,524	Acrolein	5.67E+11	94.52%	1
18	D001 K013 U003	2869	A33	B219	5,554	Acrolein	5.54E+11	94.81%	93
19	D001 F001 F002 F003	Unkwn	Unkwn	B204	10,782	Selenium	5.38E+11	95.10%	56
20	D001 D008	2821	A33	B602	13,395	Lead	5.35E+11	95.38%	44
21	K048 K049 K051	Unkwn	Unkwn	Unkwn	3,393	Mercury	5.08E+11	95.64%	134
22	F003 F005	2819	A	B	6,101	Lead	4.57E+11	95.88%	84
23	D001 F003 F005	Unkwn	Unkwn	B203	5,692	Lead	4.54E+11	96.12%	90
24	D001 D004 D005 D006 D007	Unkwn	Unkwn	B204	22,251	Cadmium	4.44E+11	96.35%	25
25	D001 D002 F002 F003 F005 U002 U012 U031 U044 U080	2834	A37	B201	4,163	Aniline	4.15E+11	96.57%	116
26	D001 D002 D003 D008 D018 D023 D024 D025 D026	2869	A33	B219	18,825	Benzene	3.76E+11	96.77%	27
27	D001 D018 D019 D022 D028	2869	A37	B202	8,416	Benzene	3.36E+11	96.94%	62
28	K051	2911	A89	B603	6,217	Lead	2.92E+11	97.10%	83
29	D001 D002 D007 D018 D021 F002 F003 F005	2865	A31	B204	4,781	Benzene	2.86E+11	97.25%	102
30	D001 D002 D003 D018 D026 D035 F002 F003 F004 F005	2869	A33	B219	14,194	Benzene	2.83E+11	97.39%	42
31	D001 D004 D005 D006 D007 D008 D009 D010 D011 D016	Unkwn	Unkwn	B202	6,591	Mercury	2.63E+11	97.53%	78
32	D001 F003 F005	Unkwn	Unkwn	B204	8,747	Lead	2.62E+11	97.67%	60
33	D001 D002	2819	A37	B219	15,997	Aniline	2.39E+11	97.79%	37
34	K049	2911	A75	B202	3,316	Bis (2-ethylhexyl) phthalate	2.32E+11	97.92%	135
35	D001 D004 D005 D006 D007 D008 D009 D010 D011 D018	Unkwn	Unkwn	B202	5,565	Benzene	2.22E+11	98.03%	92
36	D001 D005 D006 D007 D008	7389	A89	B204	10,883	Cadmium	2.17E+11	98.15%	53
37	D018 F037 F038 K048 K049 K050 K051	2911	A75	B603	10,580	Benzene	2.11E+11	98.26%	57
38	D001 D004 D005 D006 D007 D008 D009 D010 D016 F001	7389	A71	B219	4,743	Mercury	1.89E+11	98.36%	103
39	D001 D002 D003 D004 D005 D006 D007 D008 D009 D010	4953	A99	B114	4,564	Mercury	1.82E+11	98.45%	106
40	D001 D004 D005 D006 D007 D008 D010 D011 D018 D035	2899	A89	B204	4,531	Mercury	1.81E+11	98.55%	107
41	D001 D002 D007 D018 D021 F002 F003 F005	2865	A34	B204	4,316	Benzene	1.72E+11	98.64%	113

EXHIBIT 3-4 (continued)

TOP 100 WASTESTREAM COMBINATIONS, RANKED BY HAZARD SCORES

Rank	Wastestream Combination	SIC Code	Source Code	Form Code	Volume (Tons)	Hazard-Driving Constituent	Wastestream Combination Score	Cum. Percent	Volume Rank
42	D001 D007 D008 D018	2911	A89	B204	8,564	Benzene	1.71E+11	98.73%	61
43	D001 D005 D006 D007 D008	Unkwn	Unkwn	B407	7,826	Cadmium	1.56E+11	98.81%	68
44	D001 D018 K048 K049	2911	Unkwn	B204	3,669	Benzene	1.46E+11	98.88%	126
45	Unknown	3221	A54	B206	7,914	Lead	1.18E+11	98.95%	67
46	D001 F024	2819	A33	B219	14,893	1,3-Dichloropropene	1.04E+11	99.00%	39
47	K048	2911	A75	B503	19,996	Benzo(a)pyrene	9.98E+10	99.05%	26
48	D001 D004 D005 D006 D007	Unkwn	Unkwn	B407	4,509	Cadmium	9.00E+10	99.10%	108
49	D001 D002	2869	A33	B219	7,412	Benzene	8.87E+10	99.15%	70
50	D005 D006 D008 F001	4953	Unkwn	B204	4,348	Cadmium	8.68E+10	99.19%	111
51	D018 D038 K022 K083	2865	A	B	17,303	Phenol	8.63E+10	99.24%	33
52	D001 D005 D006 D007	Unkwn	Unkwn	B204	3,775	Cadmium	7.53E+10	99.28%	124
53	D001 D011 D018 D021 D022	3861	A49	B204	9,390	Benzene	7.49E+10	99.32%	59
54	D001 F001 F003 F005	Unkwn	Unkwn	B204	5,956	Selenium	7.43E+10	99.35%	86
55	D001 D002 D007	2869	A33	B602	36,709	Xylene	7.32E+10	99.39%	14
56	D001 D005 D006 D007 D008 F001 F002 F003 F004 F005	7389	A71	B206	3,518	Benzo(a)anthracene	7.02E+10	99.43%	129
57	D001 D005 D006 D007 D008 F003 F005	2821	A73	B602	3,410	Cadmium	6.80E+10	99.46%	133
58	D001 D002 D005 D006	4953	Unkwn	B204	3,295	Cadmium	6.57E+10	99.50%	136
59	D001 D002 D019 D022 D027 D028 D029 D032 D033 D034	2869	A99	B494	6,435	Hexachlorobutadiene (hexachloro-1,3-buta	6.42E+10	99.53%	80
60	D001 D006 D008 F002	Unkwn	Unkwn	B403	3,168	Cadmium	6.32E+10	99.57%	138
61	F001 F002 F003 F005	Unkwn	Unkwn	B204	6,975	Selenium	6.26E+10	99.60%	73
62	D001 D005 D006 D007 D008 D011 D022 D035 D039 F001	Unkwn	Unkwn	Unkwn	3,124	Cadmium	6.23E+10	99.63%	140
63	D001 D002 D007 D008 D018 D035 F001 F003 F005 U009	2869	A37	B219	5,679	Lead	5.67E+10	99.66%	91
64	D001 F001 F002 F005	Unkwn	Unkwn	B204	10,929	Acrylonitrile	5.45E+10	99.69%	52
65	D008	Unkwn	Unkwn	Unkwn	5,357	Lead	5.34E+10	99.72%	95
66	D001 F004	2821	A33	B602	3,990	Phenol	5.18E+10	99.74%	119
67	D001 D007 D008 F001 F002 F003 F005	9999	Unkwn	B202	4,866	Lead	4.85E+10	99.77%	99
68	K022	2865	A33	B602	9,432	Phenol	4.71E+10	99.79%	58
69	K022	2869	A33	B219	10,846	Phenol	3.25E+10	99.81%	54
70	D001 D002 D007	2869	A33	B219	16,099	Xylene	3.21E+10	99.83%	36
71	D001 F001 F002 F003	2899	A89	B204	5,825	Selenium	2.91E+10	99.84%	88
72	D001 D002 F003 F005 K038 P094	2879	A37	B101	35,136	Xylene	2.80E+10	99.86%	15
73	D001 D002 D003 D004 D005 D006 D007 D008 D009 D010	2869	A33	B105	13,182	Xylene	2.63E+10	99.87%	45
74	K017 K019 K020	2869	A33	B601	13,073	1,1,2-Trichloroethane	2.61E+10	99.89%	46
75	D001	2512	A92	B403	4,322	Lead	2.59E+10	99.90%	112
76	D001 D018 D043 F001 F002 F003 F004 F005	Unkwn	Unkwn	B204	15,509	Carbon tetrachloride	2.48E+10	99.91%	38
77	F001 F002 F003	Unkwn	Unkwn	Unkwn	4,822	Selenium	2.41E+10	99.93%	101
78	K022	2865	A35	B602	4,609	Phenol	2.30E+10	99.94%	105
79	D001 F003 F005	3053	A56	B403	3,465	Xylene	2.28E+10	99.95%	131
80	D002 D021 D028 F003 F005	2879	A37	B101	130,948	Chlorobenzene	2.22E+10	99.96%	2
81	D001	2869	A35	B207	10,782	Xylene	2.14E+10	99.97%	56
82	D001	2869	A35	B606	3,175	Benzene	1.27E+10	99.98%	137

EXHIBIT 3-4 (continued)

TOP 100 WASTESTREAM COMBINATIONS, RANKED BY HAZARD SCORES

Rank	Wastestream Combination	SIC Code	Source Code	Form Code	Volume (Tons)	Hazard-Driving Constituent	Wastestream Combination Score	Cum. Percent	Volume Rank
83	D001	Unkwn	Unkwn	Unkwn	25,371	1,2-Dichloropropane	1.01E+10	99.98%	23
84	D001 F001 F002 F003 F005	Unkwn	Unkwn	B202	5,922	Carbon tetrachloride	9.45E+09	99.99%	87
85	D001 D002	Unkwn	Unkwn	Unkwn	3,477	Xylene	6.94E+09	99.99%	130
86	D001 F002 F003 F005	2384	A37	B101	18,747	Benzene	5.61E+09	100.00%	29
87	D001 F002 F003 F005	2833	A35	B101	26,284	Toluene	2.10E+09	100.00%	21
88	D001 D022	2869	A37	B202	3,414	Chloroform	1.16E+09	100.00%	132
89	F002 F005	2834	A37	B101	28,640	Xylene	1.14E+09	100.00%	18
90	D001 D002 D003	2879	A37	B102	27,247	Selenium	8.16E+08	100.00%	19
91	D002	2869	A09	B207	8,001	Copper	7.98E+08	100.00%	65
92	D001	2869	A35	B219	12,842	Mercury	6.41E+08	100.00%	47
93	D001 D002 D003 D018 D021 D023 D024 D025 D026 D035	2869	A33	B219	7,418	Chlorobenzene	5.03E+08	100.00%	69
94	K027	2865	A33	B409	11,123	Ethyl benzene	4.44E+08	100.00%	49
95	D001 D002 D003 D005 D018 D021 D023 D024 D025 D026	2869	Unkwn	Unkwn	6,075	Chlorobenzene	4.12E+08	100.00%	85
96	D001 D002 F003	2819	A	B	5,323	Mercury	1.06E+08	100.00%	96
97	K027	2865	A33	B403	4,457	Ethyl benzene	8.89E+07	100.00%	110
98	D001 F002 F003	2833	A35	B101	18,154	Methylene chloride	5.43E+07	100.00%	31
99	F002	2879	A35	B101	37,447	Methylene chloride	1.79E+07	100.00%	12
100	F002 F003 F005	2384	A37	B101	6,414	1,1,2-Trichloroethane	5.12E+06	100.00%	81
							1.909E+14		

Note: EPA reviewed the composition of the 150 largest-quantity wastestream combinations to identify the top 100 containing metals and/or halogenated organics. Thus, the entries in the column headed "Volume Rank" range as high as 140 – this wastestream was the 100[th] largest that contained metals and/or halogenated organics.

Because much of the total score is dominated by the top five wastestream combinations, and the subsequent discussion of waste origins is driven by the scores of these wastestream combinations, some of their principal characteristics are described below.

- D001 F001 F002 F003 F005 U001 U002 U003 U019 U028; "other" organic liquid; from product distillation in the industrial organic chemicals industry. Based on the waste codes, EPA characterized the top-ranked wastestream combination as consisting primarily of off-specification commercial products and spent solvents. The Agency determined that 13 different constituents, including eight halogenated organics, were likely to be present in the wastestream combination in approximately equal concentrations (assumed to be 50,000 ppm for each constituent). Of these, bis 2-(ethylhexyl) phthalate received the highest constituent hazard score.

- D002 D006; concentrated aqueous solution of other organics; from product filtering from the medicinal chemicals and botanical products industry. EPA characterized the number two-ranked wastestream combination based on the constituents and concentrations reported in the GENSUR, for an identical set of RCRA codes and waste form. The composition of this wastestream combination included cadmium at a concentration of 100,000 ppm, as reported in GENSUR; cadmium received the highest constituent hazard score.

- K022; organic sludge containing resins, tars, or tarry sludge; from product distillation in the industrial organic chemicals industry. The RCRA code for this wastestream combination indicates "distillation bottom tars from the production of phenol/acetone from cumene." Based on constituent data from GENSUR for the same RCRA code and SIC, EPA characterized this wastestream combination as containing about 30 constituents. Based on the waste form -- tarry sludge -- the Agency estimated that the polynuclear aromatic hydrocarbons (PAHs) present would have relatively high concentrations, on the order of 10,000 ppm each.[9] Of the 30 organic and metal constituents, the highest hazard score was assigned to fluoranthene, one of the PAHs.

- D001 D002 D019 D032 D033 D034 D039 F002; "other organic liquid; from product distillation in the industrial organic chemicals industry. This wastestream combination includes five toxicity characteristic codes, as well as a halogenated solvent code (F002). Based on the waste codes, the BRS notation that the wastestream combination was the subject of a Toxics Release Inventory (TRI) report that it contained chloropyridine, and GENSUR data, EPA characterized this wastestream combination as containing 11 hazardous constituents plus hydrochloric acid (assumed to impart the corrosivity characteristic). Chloropyridine was assumed to have a concentration of 150,000 ppm; the other seven organics

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[9] Note that two other K022 wastestreams were among the top 100. One of them, generated by the same SIC but in the form of an organic liquid, was assumed to have the exact concentrations reported in the GENSUR (this wastestream has a rank of 69 in Exhibit 3-4). The other is generated by a different SIC, which matched with another wastestream reported in the GENSUR, and was characterized based on constituents and concentrations reported for the other SIC. It appears at rank 68 in Exhibit 3-4.

present were assumed to have concentrations of 50,000 ppm each. The hazard-driving constituent is hexachlorobutadiene.

- D001 D007 D008 D018 D022 D026 D027 D028 D033 D036; "other organic liquid; from an unspecified process in the "nonclassifiable establishments" SIC. This wastestream combination includes nine toxicity characteristic codes. Based on the waste codes and the waste form, EPA characterized this wastestream combination as containing the nine TC hazardous constituents, and assumed that ignitability was imparted by one or more of these constituents. The organics present were assumed to have concentrations of 15,000 ppm each. As with the fourth-ranked wastestream combination, the hazard-driving constituent is hexachlorobutadiene.

The scores of the five top-ranked wastestream combinations are driven by constituents that are non-halogenated organics (bis 2-(ethylhexyl) phthalate, fluoranthene), metals (cadmium), or halogenated organics (hexachlorobutadiene). Exhibit 3-5 further illustrates this point, i.e., that the top hazard-driving constituents belong to all three classes (non-halogenated organics, metals, and halogenated organics).[10] The hazard-driving constituents are ranked in Exhibit 3-5 according to their total hazard score, summed across all 100 ranked wastestream combinations. Bis 2-(ethylhexyl) phthalate appears to account for almost 40 percent of the total hazard score; this is consistent with the fact that it is the hazard-driving constituent for the top-ranked wastestream combination, which has a high hazard score relative to all other wastestream combinations. Again, the results indicate that about 86 percent of the total hazard score is due to just four of the top-ranking constituents.

The hazard scores for 65 of the 100 wastestream combinations were derived based on two HRS pathways: (1) surface water/environmental threat pathway, and (2) surface water/human food chain threat pathway (both for the overland flow/flood component). Together, these two "hazard-driving pathways," i.e., pathways for which the hazard-driving constituent received the maximum score, account for about 96 percent of the total hazard score, across all wastestream combinations. Constituents are assigned pathway scores for the surface water environmental or human food chain threat pathways based on ecological/human toxicity, persistence, and bioaccumulation potential.

Exhibit 3-6 shows how the form codes rank according to the hazard score. Three waste forms -- "other" organic liquids, concentrated aqueous solution of other organics, and resins -- comprise almost 92 percent of the total hazard score (primarily because they are associated with the top five wastestream combinations). Non-halogenated and halogenated solvents comprise most of the remaining share of the total hazard score.

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[10] Note that, by definition, the top 100 wastestream combinations were selected because they contained metals and/or halogenated organics. In addition to these constituents, the wastestreams may also contain non-halogenated organic constituents. Depending on their relative hazard, the non-halogenated organics can appear as the "hazard-driving constituents".

EXHIBIT 3-5

HAZARD-DRIVING CONSTITUENTS, RANKED BY HAZARD SCORES (for Top 100 Wastestream Combinations)

OBS	Constituent	Key	Hazard Score	% of Hazard Score	Cum. % of Hazard Score
1	Bis (2-ethylhexyl) phthalate	Other Constituent	7.12e+13	37.28	37.28
2	Cadmium	Metal	3.91e+13	20.49	57.77
3	Hexachlorobutadiene (hexachloro-1,3-butadiene	Halogenated Organic	3.12e+13	16.33	74.10
4	Fluoranthene	Other Constituent	2.32e+13	12.17	86.27
5	Lead	Metal	5.39e+12	2.82	89.09
6	Tetrachlorobenzene	Halogenated Organic	4.79e+12	2.51	91.60
7	Mercury	Metal	3.90e+12	2.04	93.64
8	Benzo(a)anthracene	Other Constituent	2.43e+12	1.27	94.91
9	Benzene	Other Constituent	2.39e+12	1.25	96.16
10	Aniline	Other Constituent	2.08e+12	1.09	97.25
11	Hexachlorocyclopentadiene	Halogenated Organic	1.93e+12	1.01	98.26
12	Acrolein	Other Constituent	1.12e+12	0.59	98.85
13	Selenium	Metal	7.29e+11	0.38	99.23
14	Hexachlorobenzene	Halogenated Organic	6.25e+11	0.33	99.56
15	Phenol	Other Constituent	2.41e+11	0.13	99.69
16	Xylene	Other Constituent	2.12e+11	0.11	99.80
17	1,3-Dichloropropene	Halogenated Organic	1.04e+11	0.05	99.85
18	Benzo(a)pyrene	Other Constituent	9.98e+10	0.05	99.90
19	Acrylonitrile	Other Constituent	5.45e+10	0.03	99.93
20	Carbon tetrachloride	Halogenated Organic	3.42e+10	0.02	99.95
21	1,1,2-Trichloroethane	Halogenated Organic	2.61e+10	0.01	99.96
22	Chlorobenzene	Halogenated Organic	2.31e+10	0.01	99.97
23	1,2-Dichloropropane	Halogenated Organic	1.01e+10	0.01	99.98
24	Toluene	Other Constituent	2.10e+09	0.00	99.98
25	Chloroform	Halogenated Organic	1.16e+09	0.00	99.98
26	Copper	Metal	7.98e+08	0.00	99.98
27	Ethyl benzene	Other Constituent	5.33e+08	0.00	99.98
28	Methylene chloride	Halogenated Organic	7.23e+07	0.00	99.98
		Total	1.91e+14	99.98	

EXHIBIT 3-6

FORM CODES, RANKED BY HAZARD SCORES

Hazard Rank	Form Code Description	Form Code	Hazard Score	% of Hazard	Cum % of Hazard
1	Other organic liquids	B219	1.13e+14	59.05	59.05
2	Concentrated aqueous solution of other organics	B207	3.91e+13	20.49	79.54
3	Resins	B606	2.32e+13	12.18	91.72
4	Non-halogenated solvent	B203	3.54e+12	1.86	93.57
5	Halogenated/non-halogenated solvent mixture	B204	2.97e+12	1.55	95.13
6	Halogenated solvent	B202	2.44e+12	1.28	96.41
7	Waste oil	B206	1.87e+12	0.98	97.39
8	Unknown	Unk.	1.21e+12	0.63	98.02
9	Still bottoms of non-halogenated solvents	B602	7.98e+11	0.42	98.44
10	Oil-water emulsion or mixture	B205	6.77e+11	0.35	98.79
11	Aqueous waste with low solvents	B101	6.26e+11	0.33	99.12
12	Oily sludge	B603	5.03e+11	0.26	99.39
13	Concentrated solvent-water solution	B201	4.15e+11	0.22	99.60
14	Other halogenated organic solids	B407	2.46e+11	0.13	99.73
15	Other aqueous waste with low dissolved solids	B114	1.82e+11	0.10	99.83
16	Solid resins or polymerized organics	B403	1.12e+11	0.06	99.89
17	Lime sludge with metals/metal hydroxide sludge	B503	9.98e+10	0.05	99.94
18	Unknown	B494	6.42e+10	0.03	99.97
19	Acidic aqueous waste	B105	2.63e+10	0.01	99.99
20	Still bottoms of halogenated solvents	B601	2.61e+10	0.01	100.00
21	Aqueous waste with low other toxic organics	B102	8.16e+08	0.00	100.00
22	Other non-halogenated organic solids	B409	4.44e+08	0.00	100.00

3.2.2 Scores and Ranks Based on Waste Origins

Exhibit 3-7 shows how the SIC Code/Source Code combinations rank in terms of their hazard scores. Again, about 85 percent of the total hazard score (sum of scores across all SIC Code/Source Code combinations) is contributed by three combinations:

- SIC Code 2869 (Industrial Organic Chemicals)/Source Code A33 (Product Distillation);

- SIC Code 2833 (Medicinal Chemicals and Botanical Products)/Source Code A32 (Product Filtering); and

- Non-classifiable SIC Code/Unspecified Source Code.

These constitute the combinations representing the top five wastestream combinations. The next combination, unknown SIC and unknown source, primarily comprises non-halogenated solvents (the seventh-ranked wastestream combination) and waste oils (the tenth-ranked wastestream combination).

Exhibits 3-8 and 3-9 indicate how the hazard scores apportion to the SIC Codes and Source Codes individually. These exhibits again show that overall wastestream combination hazard is being dominated by just a handful of SIC Code and Source Code combinations.

Finally, most of the ten top-ranked wastestream combinations represent a small number of BRS records of wastestreams at a few facilities, as shown in Exhibit 3-10. The nine top-ranking wastestream combinations are focused in 20 or fewer facilities; slightly less than half of these facilities manage their wastes on site. This indicates that for the nine highest-hazard wastestream combinations, there is an opportunity to focus the next phase of the prioritization and waste minimization effort within a relatively small set of facilities. This may allow for site-specific data collection and evaluation of waste minimization potential. The tenth-ranked wastestream combination, waste oils, is generated by a much larger set of facilities, many of whom ship wastes off site.

Also, the draft results indicate that a majority of the nine top-ranking wastestream combinations are focused primarily in the States of Texas, Connecticut, Pennsylvania, and Virginia. Three of these states account for a large percentage of the total hazard score across all wastestream combinations, i.e., Texas (≈ 53 percent), Connecticut (≈ 20 percent), and Pennsylvania (≈ 13 percent); see Exhibit 3-11. A detailed listing of states and regions corresponding to the top 100 ranked wastestream combinations is provided in Appendix 9.

3.2.3 Summary

EPA emphasizes that this report presents **draft results**, and views this effort as a work in progress rather than a final analysis. The Agency is interested in receiving comments on how the methodology for prioritization can be improved and how better data for use in the scoring and ranking can be obtained. The draft results in this report should be viewed in light of the following points:

- EPA's primary objective in developing the prioritization methodology is to create a useful overall **framework** for national-level screening analysis, that while initially

EXHIBIT 3-7

SIC CODE/SOURCE CODE COMBINATIONS, RANKED BY HAZARD SCORES

Hazard Rank	SIC Code Description	SIC Code	Source Code Description	Source Code	Hazard Score	% of Hazard	Cum % of Hazard
1	Industrial Organic Chemicals, N.E.C.	2869	Product distillation	A33	1.16e+14	60.85	60.85
2	Medicinal Chemicals and Botanical Products	2833	Product filtering	A32	3.72e+13	19.47	80.32
3	Nonclassifiable Establishments	9999	Other	A99	1.05e+13	5.49	85.81
4	Unknown	Unk.	Unknown	Unk	8.34e+12	4.37	90.18
5	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	Spent process liquids removal	A37	4.79e+12	2.51	92.69
6	Refuse Systems	4953	Solvents recovery	A73	2.43e+12	1.28	93.96
7	Industrial Organic Chemicals, N.E.C.	2869	Product rinsing	A31	1.93e+12	1.01	94.98
8	Industrial Organic Chemicals, N.E.C.	2869	By-product processing	A35	1.46e+12	0.76	95.74
9	Industrial Organic Chemicals, N.E.C.	2869	Incineration/Thermal treatment	A74	1.33e+12	0.70	96.44
10	Petroleum Refining	2911	Other pollution control or waste treatment	A89	1.14e+12	0.60	97.03
11	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	Product distillation	A33	7.01e+11	0.37	97.40
12	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	Product distillation	A33	5.86e+11	0.31	97.71
13	Petroleum Refining	2911	Wastewater treatment	A75	5.42e+11	0.28	97.99
14	Industrial Inorganic Chemicals, N.E.C.	2819	Unknown	Unk	4.57e+11	0.24	98.23
15	Pharmaceutical Preparations	2834	Spent process liquids removal	A37	4.22e+11	0.22	98.45
16	Industrial Organic Chemicals, N.E.C.	2869	Spent process liquids removal	A37	3.94e+11	0.21	98.66
17	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	Product rinsing	A31	2.86e+11	0.15	98.81
18	Business Services, N.E.C.	7389	Filtering/screening	A71	2.59e+11	0.14	98.95
19	Industrial Inorganic Chemicals, N.E.C.	2819	Spent process liquids removal	A37	2.39e+11	0.13	99.07
20	Business Services, N.E.C.	7389	Other pollution control or waste treatment	A89	2.17e+11	0.11	99.19
21	Chemicals and Chemical Preparations, N.E.C.	2899	Other pollution control or waste treatment	A89	2.10e+11	0.11	99.30

EXHIBIT 3-7 (continued)

SIC CODE/SOURCE CODE COMBINATIONS, RANKED BY HAZARD SCORES

Hazard Rank	SIC Code Description	SIC Code	Source Code Description	Source Code	Hazard Score	% of Hazard	Cum % of Hazard
22	Refuse Systems	4953	Other	A99	1.82e+11	0.10	99.39
23	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	Product solvent extraction	A34	1.72e+11	0.09	99.48
24	Refuse Systems	4953	Unknown	Unk	1.53e+11	0.08	99.56
25	Petroleum Refining	2911	Unknown	Unk	1.46e+11	0.08	99.64
26	Glass Containers	3221	Oil changes	A54	1.18e+11	0.06	99.70
27	Industrial Inorganic Chemicals, N.E.C.	2819	Product distillation	A33	1.04e+11	0.05	99.75
28	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	Unknown	Unk	8.63e+10	0.05	99.80
29	Photographic Equipment and Supplies	3861	Other non-surface preparation processes	A49	7.49e+10	0.04	99.84
30	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	Solvents recovery	A73	6.80e+10	0.04	99.87
31	Industrial Organic Chemicals, N.E.C.	2869	Other	A99	6.42e+10	0.03	99.91
32	Pesticides and Agricultural Chemicals, N.E.C.	2879	Spent process liquids removal	A37	5.11e+10	0.03	99.94
33	Nonclassifiable Establishments	9999	Unknown	Unk	4.85e+10	0.03	99.96
34	Wood Household Furniture, Upholstered	2512	Routine cleanup wastes	A92	2.59e+10	0.01	99.97
35	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	By-product processing	A35	2.30e+10	0.01	99.99
36	Gaskets, Packing, and Sealing Devices	3053	Discontinue use of process equipment	A56	2.28e+10	0.01	100.00
37	Medicinal Chemicals and Botanical Products	2833	By-product processing	A35	2.15e+09	0.00	100.00
38	Industrial Organic Chemicals, N.E.C.	2869	Clean out process equipment	A09	7.98e+08	0.00	100.00
39	Industrial Organic Chemicals, N.E.C.	2869	Unknown	Unk	4.12e+08	0.00	100.00
40	Pesticides and Agricultural Chemicals, N.E.C.	2879	By-product processing	A35	1.79e+07	0.00	100.00

EXHIBIT 3-8

SIC CODES, RANKED BY HAZARD SCORE

Hazard Rank	SIC Code Description	SIC Code	Hazard Score	% of Hazard	Cum % of Hazard
1	Industrial Organic Chemicals, N.E.C.	2869	1.21e+14	63.56	63.56
2	Medicinal Chemicals and Botanical Products	2833	3.72e+13	19.47	83.03
3	Nonclassifiable Establishments	9999	1.05e+13	5.52	88.55
4	Unknown	Unk.	8.34e+12	4.37	92.92
5	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	5.45e+12	2.85	95.77
6	Refuse Systems	4953	2.77e+12	1.45	97.22
7	Petroleum Refining	2911	1.83e+12	0.96	98.18
8	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	1.27e+12	0.67	98.85
9	Industrial Inorganic Chemicals, N.E.C.	2819	8.00e+11	0.42	99.27
10	Business Services, N.E.C.	7389	4.77e+11	0.25	99.52
11	Pharmaceutical Preparations	2834	4.22e+11	0.22	99.74
12	Chemicals and Chemical Preparations, N.E.C.	2899	2.10e+11	0.11	99.85
13	Glass Containers	3221	1.18e+11	0.06	99.91
14	Photographic Equipment and Supplies	3861	7.49e+10	0.04	99.95
15	Pesticides and Agricultural Chemicals, N.E.C.	2879	5.11e+10	0.03	99.97
16	Wood Household Furniture, Upholstered	2512	2.59e+10	0.01	99.99
17	Gaskets, Packing, and Sealing Devices	3053	2.28e+10	0.01	100.00

EXHIBIT 3-9

SOURCE CODES, RANKED BY HAZARD SCORES

Hazard Rank	Source Code Description	Source Code	Hazard Score	% of Hazard	Cum. % of Hazard
1	Product distillation	A33	1.18e+14	61.58	61.58
2	Product filtering	A32	3.72e+13	19.47	81.05
3	Other	A99	1.07e+13	5.62	86.66
4	Unknown	Unk	9.23e+12	4.84	91.50
5	Spent process liquids removal	A37	5.90e+12	3.09	94.59
6	Solvents recovery	A73	2.50e+12	1.31	95.90
7	Product rinsing	A31	2.22e+12	1.16	97.07
8	Other pollution control or waste treatment	A89	1.57e+12	0.82	97.89
9	By-product processing	A35	1.48e+12	0.78	98.66
10	Incineration/Thermal treatment	A74	1.33e+12	0.70	99.36
11	Wastewater treatment	A75	5.42e+11	0.28	99.65
12	Filtering/screening	A71	2.59e+11	0.14	99.78
13	Product solvent extraction	A34	1.72e+11	0.09	99.87
14	Oil changes	A54	1.18e+11	0.06	99.93
15	Other non-surface preparation processes	A49	7.49e+10	0.04	99.97
16	Routine cleanup wastes	A92	2.59e+10	0.01	99.99
17	Discontinue use of process equipment	A56	2.28e+10	0.01	100.00
18	Clean out process equipment	A09	7.98e+08	0.00	100.00

EXHIBIT 3-10

GENERATION AND MANAGEMENT PATTERNS FOR THE TOP TEN-RANKED WASTESTREAM COMBINATIONS

Wastestream Combination Rank	1	2	3	4	5	6	7	8	9	10
No. of BRS Records of Wastestreams	3	1	1	2	1	2	12	1	1	450
No. of Facilities	1	1	1	1	1	1	12	1	1	450
Place of Management	on site	on site	on site	on site	off site	on site	off site	on site	on site	both
Region	VI	I	III	VI	V	VI	I,II,III	IV	III	many
State	TX	CT	PA	TX	IN	TX	CT,MA, NJ,NY, PA,VA, WV	KY	VA	many

EXHIBIT 3-11

TOP 100 COMBUSTED WASTESTREAM HAZARD SCORES BY REGION AND STATE

Region	State	Hazard Score	% of Total
1	CT	3.72e+13	19.50
	MA	2.04e+11	0.10
2	NJ	3.30e+12	1.70
	NY	3.17e+11	0.20
3	PA	2.38e+13	12.50
	VA	2.00e+12	1.00
4	AL	3.27e+11	0.20
	FL	4.44e+11	0.20
	GA	4.66e+11	0.20
	KY	3.01e+12	1.60
	TN	6.75e+11	0.40
5	IL	2.67e+11	0.10
	IN	1.07e+13	5.60
	MI	1.15e+12	0.60
	OH	1.22e+12	0.60
	WI	2.05e+11	0.10
6	AR	6.05e+11	0.30
	LA	2.94e+12	1.50
	TX	1.01e+14	53.10
7	MO	3.20e+11	0.20
	Other States	3.33e+11	0.17
	Total:	**1.91e+14**	**100.00**

Note: @ - States with hazard score percentages less than 0.1 percent are not listed.

focused on combusted hazardous wastes, could also potentially be applied to wastes managed by other practices.

- EPA recognizes that factors other than hazard may also be important in setting priorities for waste minimization. Some examples include:

  - technical and economic feasibility of waste minimization alternatives
  - potential to build on other ongoing pollution prevention activities
  - waste treatment/management capacity
  - environmental justice concerns
  - potential for wastes to cause difficult remediation problems (e.g., dense non-aqueous phase liquids are particularly difficult to remediate when they contaminate ground water).

- EPA will continue refining the prioritization methodology and investigating alternative data sources based on comments received.

3.3 LIMITATIONS

Most of the limitations associated with the scoring and ranking methodology fall into one of two categories: (1) limitations due to the uncertainty of the underlying waste characterization data; or (2) limitations inherent to the scoring method. A key limitation in the first category is briefly described below:

- <u>Hazard scores are subject to the uncertainty in the underlying waste characterization/constituent concentration data</u>. As discussed in Chapter 2, there is significant uncertainty associated with the constituent content and concentrations that were estimated for each wastestream combination. For example, due to the nature of the data sources used, constituent content and concentration estimates may not correspond completely to current waste characteristics, and may not reflect the variability of waste characteristics over time and across generators. Because the scoring methodology relies directly on the constituent content and concentration, the hazard scores are limited by the same uncertainty that is inherent in the underlying data.

Limitations in the second category include those that are common to most screening-level scoring and ranking approaches, those that apply to the HRS, and those associated with using components of the HRS for this specific application, i.e., ranking wastestream combinations.

- <u>Method incorporates assumptions and limitations of the HRS</u>. Because it is a screening-level scoring and ranking approach, the HRS incorporates certain simplifying assumptions. For example, ecosystem hazard is evaluated using an aquatic ecosystem model only; terrestrial ecosystems are not accounted for. Furthermore, human toxicity is not differentiated by route of exposure. The effect of these simplifying assumptions is thus indirectly conveyed to the wastestream scores and ranks. (For more discussion of the assumptions and their rationale in the HRS, see *55 Federal Register 51532.*)

- Approach does not account for hazards related to corrosive and ignitable/flammable nature of some hazardous wastestreams. Some of the hazardous wastestreams contain constituents that render the wastestreams ignitable, corrosive, or reactive. The hazard scoring methodology does not factor into the final scores, the types of acute hazards to humans or ecosystems that these wastestreams may pose.

- Method does not directly address releases and exposures, particularly post-combustion releases and exposures. The scoring methodology accounts for constituent properties that relate to the *potential* for exposure; however, the methodology contains no mechanism to account for direct releases and exposures (or system controls that prevent or reduce releases). Therefore, unique aspects of Subtitle C waste management to which the wastestreams are subject (e.g., destruction and removal in combustion) and site-specific characteristics (size of population that could potentially be exposed if releases occur) are not considered in this screening-level scoring methodology.

- Method does not correspond directly to a measure of "absolute" risk. The scoring system is intended to provide an indication of the relative hazard of different wastestreams. It does not, however, indicate whether the risks posed by combustion of the wastes are in the range that EPA typically considers significant.

As a practical matter, any method that seeks to simulate complex environmental processes, but is founded on simple scoring algorithms and uncertain data, will always carry with it severe limitations. Some of these limitations may become less constraining as the approach is refined and improved. The Agency looks forward to receiving comments and data on the proposed approach for setting priorities for waste minimization, and will carefully consider all information it receives.